**2(a) How is Mean Absolute Deviation (MAD) calculated in forecasting?**  
MAD is calculated using the formula:

MAD=∑t=1n∣Ft−Dt∣nMAD = \frac{\sum\_{t=1}^{n} |F\_t - D\_t|}{n}

Where:

* tt is the period number,
* DtD\_t is the demand in period tt,
* FtF\_t is the forecast for period tt,
* nn is the total number of periods.  
  This formula measures the average absolute errors between the forecasted and actual demands over a period of time

**2(b) What factors are considered when choosing a facility location using the gravity method?**  
The gravity method minimizes the total material handling cost based on the squared Euclidean distance. Factors considered include:

1. Coordinates (xx and yy) of the existing facilities.
2. Weights (wiw\_i) associated with each existing facility, representing the material flow or interaction.
3. Optimal location coordinates (x∗,y∗)(x^\*, y^\*), calculated as weighted averages of the existing facility coordinates

**2(c) Describe the differences between job shop, batch, and mass production systems.**

* **Job Shop**: Produces small batches of custom-designed products, each following unique processing steps (e.g., furniture manufacturing). Suitable for high product variety and low volume.
* **Batch Production**: Produces a limited variety of products in medium volumes. Repetition occurs for different batches, such as in bakeries or medicine production.
* **Mass Production**: Produces standardized products in high volumes using specialized equipment on an assembly line (e.g., auto assembly)

**3(a) What is the significance of a learning curve in operations management?**  
The learning curve demonstrates how labor hours required per unit decrease as production volume increases due to:

1. Workers becoming more skilled.
2. Improved production methods and tooling.
3. Enhanced layout and workflow.  
   It helps in capacity planning, job design, and production cost estimation

**3(b) Explain the concept of productivity and its measurement indices.**  
Productivity is the ratio of output produced to the input resources utilized.

* **Total Productivity**: Total Output/Total Input\text{Total Output} / \text{Total Input}.
* **Partial Productivity Indices**: Measure efficiency for specific inputs, such as:
  + Labor Productivity: Output/Man Hours Worked\text{Output} / \text{Man Hours Worked},
  + Machine Productivity: Output/Machine Hours Worked\text{Output} / \text{Machine Hours Worked},
  + Land Productivity: Output/Area of Land Used\text{Output} / \text{Area of Land Used}

**3(c) What is the difference between qualitative and quantitative forecasting methods?**

* **Quantitative Methods**: Use numerical data and statistical models, such as time-series (moving averages, exponential smoothing) and causal methods.
* **Qualitative Methods**: Rely on expert judgment, intuition, and market research, used when historical data is insufficient

**4(a) Define the critical path method (CPM) and its role in project scheduling.**  
The Critical Path Method (CPM) identifies the sequence of activities determining the total project duration. Its key role is to:

* Plan project timelines,
* Identify critical tasks requiring close monitoring,
* Optimize resource allocation

**4(b) What are the steps involved in the systematic layout planning (SLP) process?**  
SLP involves:

1. Identifying the activities to be performed.
2. Developing a network model for layout design.
3. Analyzing relationships and space requirements.
4. Generating and evaluating alternative layouts.
5. Implementing the chosen layout

**4(c) How does the coefficient of determination help in analyzing data relationships?**  
The coefficient of determination (R2R^2) quantifies the strength of the relationship between dependent and independent variables in a regression model. It indicates the proportion of variation in the dependent variable explained by the independent variables

### ****5(a) What is the difference between free float and total float in project scheduling?****

* **Free Float**: The time an activity can be delayed without affecting the start of succeeding activities. Calculated as:  Float Finish Time Start Time DurationFree Float=(Latest Finish Time−Earliest Start Time)−Activity Duration
* **Total Float**: The time an activity can be delayed without delaying the entire project. It is associated with an activity in the network​​.

### ****5(b) Describe the importance and process of line balancing in production.****

* **Importance**: Line balancing ensures that workstations on an assembly line have balanced workloads to minimize idle time, maximize efficiency, and reduce production delays.
* **Process**:
  1. **Workstation Design**: Tasks are divided among stations to match cycle time.
  2. **Balancing Tasks**: Rearrange or add workstations/machines to equalize workload.
  3. **Cycle Time Calculation**: Ensures all work is completed within a fixed time frame​​.

### ****5(c) What are the key differences between centralized and decentralized dispatching?****

* **Centralized Dispatching**:
  1. A central department controls orders to workstations.
  2. Offers greater overall control and better resource utilization.
  3. Suitable for scenarios requiring high coordination.
* **Decentralized Dispatching**:
  1. Supervisors manage orders and priorities locally.
  2. Reduces bureaucracy and improves responsiveness to immediate issues.
  3. Best for environments where shop supervisors have strong situational awareness​​.

### ****6(a) What are the key strategies used in aggregate planning?****

1. **Pure Strategies**:
   * Utilizing inventory with a constant workforce.
   * Adjusting workforce size.
   * Subcontracting production.
   * Modifying demand patterns.
2. **Mixed Strategies**:
   * Combines various pure strategies to address demand-supply balance effectively​​.

### ****6(b) Explain the concept of cycle time and how it affects production efficiency.****

* **Cycle Time**: The time a product spends at one workstation from start to finish.
* **Impact on Efficiency**:
  + A balanced cycle time ensures smooth flow across workstations.
  + Reducing cycle time improves production output and minimizes delays​​.

### ****6(c) What is the role of quality circles in an organization?****

Quality circles are small groups of employees who regularly meet to discuss and propose solutions for work-related problems. Their roles include:

1. Improving productivity and quality.
2. Enhancing team collaboration and worker morale.
3. Addressing operational inefficiencies through collective brainstorming​​.

### ****7(a) Describe the Kanban system and its significance in lean manufacturing.****

* **Kanban System**: A visual tool used in lean manufacturing to signal workflow and manage inventory. Cards or signals are used to represent production stages and materials.
* **Significance**:
  1. Prevents overproduction and reduces inventory costs.
  2. Enhances efficiency by aligning production with actual demand.
  3. Promotes just-in-time (JIT) manufacturing

### ****7(b) How does the learning curve concept apply to production planning?****

The learning curve demonstrates that as production increases, workers become more efficient, and production costs per unit decrease. Applications include:

1. Estimating future production costs.
2. Scheduling and capacity planning.
3. Improving operational efficiency by analyzing performance trends

### ****7(c) What are the primary differences between product-focused and process-focused production systems?****

* **Product-Focused**:
  1. High volume, low variety.
  2. Assembly line or continuous production.
  3. Standardized products (e.g., auto assembly).
* **Process-Focused**:
  1. Low volume, high variety.
  2. Functional layout with flexible equipment.
  3. Customized products (e.g., job shops)

### ****8(a) Explain the various types of facility layouts and their applications.****

1. **Process Layout**: Groups similar processes (e.g., job shops).
2. **Product Layout**: Arranges facilities linearly (e.g., mass production).
3. **Fixed Position Layout**: Materials and workers come to the product (e.g., shipbuilding).
4. **Group Layout**: Combines process and product layouts to minimize transport and optimize equipment use (e.g., manufacturing cells)

### ****8(b) Explain the role of regression analysis in demand forecasting.****

Regression analysis predicts demand by identifying relationships between variables. It uses a formula y=a+bxy = a + bx, where:

* yy = forecast demand,
* xx = independent variable (e.g., time),
* aa = intercept,
* bb = slope.  
  Regression helps understand trends and patterns, enabling accurate forecasting

### ****8(c) Describe the components and importance of the supply chain management process.****

* **Components**:
  1. Suppliers.
  2. Manufacturers.
  3. Distribution channels.
  4. Retailers.
  5. Customers.
* **Importance**:
  1. Reduces costs by optimizing procurement and logistics.
  2. Improves customer satisfaction through timely delivery.
  3. Enhances coordination and transparency across the supply chain

### ****9(a) What is the role of Gantt charts in production planning and control?****

* **Role**:
  1. Visualize project timelines.
  2. Track task dependencies and completion status.
  3. Identify delays and bottlenecks to ensure efficient scheduling

### ****9(b) Explain the different types of forecasting methods used in production planning.****

1. **Time-Series Methods**: Use historical data (e.g., moving averages, exponential smoothing).
2. **Causal Methods**: Relate demand to external factors (e.g., regression analysis).
3. **Qualitative Methods**: Use expert judgment (e.g., Delphi method).
4. **Market Research**: Gathers customer insights through surveys

### ****9(c) What are the essential elements of a production function?****

* **Inputs**: Materials, labor, machines, capital.
* **Process**: Transformation of inputs into outputs.
* **Outputs**: Goods and services.  
  The function measures efficiency in converting resources into final products

### ****10(a) Explain the concept of exponential smoothing in demand forecasting.****

Exponential smoothing predicts demand by assigning exponentially decreasing weights to past observations:

Ft+1=αDt+(1−α)FtF\_{t+1} = \alpha D\_t + (1-\alpha)F\_t

Where Ft+1F\_{t+1} = forecast for the next period, DtD\_t = current demand, FtF\_t = current forecast, and α\alpha = smoothing constant.  
It reacts quickly to recent changes in demand

**10(b) How does the break-even analysis help in facility location decision-making?**

Break-even analysis compares fixed and variable costs for different facility locations. The location with the lowest total cost at the expected production volume is selected. This helps in identifying cost-effective options

### ****10(c) Discuss the significance of ISO 9000 in modern production management.****

ISO 9000 sets international standards for quality management systems.

* **Significance**:
  1. Enhances product quality and customer satisfaction.
  2. Promotes process standardization and compliance.
  3. Boosts global competitiveness and credibility