RPSC AEn-2024 Main Test Series

MECHANICAL ENGINEERING

Test 5

Test Mode : • Offline • Online

Subjects : Industrial Engineering

DETAILED EXPLANATIONS

1. Solution:

Production System: A production system is an organized arrangement of resources such as men, machines, materials, methods, and money used to carry out production activities efficiently to produce goods of required quality and quantity.

2. Solution:

(i) Technological Development
(ii) Production Methods
(iii) Organization Factors
(iv) Work Environment

3. Solution:

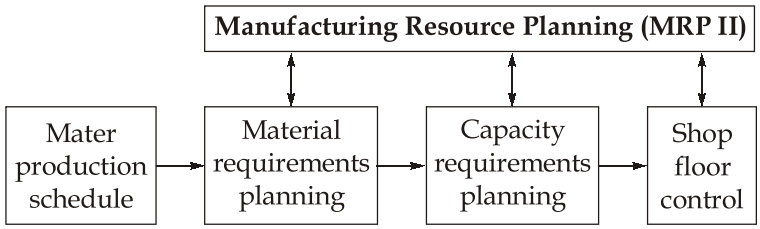
Material handling is the art and science of moving, storing, protecting, and controlling materials throughout the manufacturing process. Its importance lies in reducing production cost, minimizing material damage, improving safety, saving time and labor, and ensuring smooth flow of materials in the plant.

4. Solution:

Production Planning: Production planning is the systematic process of deciding in advance what to produce, how much to produce, when to produce, and how to produce, so that resources are utilized efficiently to meet customer demand.

5. Solution:

Manufacturing Resource Planning (MRP II) is an integrated production planning and control system that extends MRP by including all manufacturing resources such as materials, machines, labor, and finances to ensure effective planning, scheduling, and control of manufacturing activities.



6. Solution:

Scheduling is the process of fixing the time and sequence of operations for different jobs on machines so that production is completed within the planned time with optimum utilization of resources.

7. Solution:

Just-In-Time (JIT) is a production management concept in which materials and components are produced or supplied exactly when they are needed in the production process, thereby minimizing inventory, reducing waste, and improving efficiency.

8. Solution:

Project Management: Project Management is the application of planning, organizing, scheduling, and controlling resources to achieve specific objectives within a defined scope, time, and cost constraints.

9. Solution:

(i) Ordering cost refers to the expenses incurred in placing and receiving an order for materials, such as paperwork, administrative expenses, transportation, and inspection costs.

(ii) Holding cost is the cost of storing inventory, including warehousing, insurance, depreciation, obsolescence, and interest on invested capital.

10. Solution:

ABC analysis is an inventory control technique that classifies items into three categories- A, B, and C, based on their annual consumption value, with A items requiring strict control, B items moderate control, and C items simple control.

11. Solution:

The principles of plant layout design aim to ensure smooth, economical, and safe manufacturing operations. The important principles are:

1. **Principle of minimum movement:** The layout should minimize the distance moved by materials, workers, and tools to reduce handling cost and time.
2. **Principle of smooth flow:** Materials should flow in a straight line or logical sequence from raw material to finished product without backtracking or congestion.
3. **Principle of effective space utilization:** Both floor and vertical space should be used efficiently to avoid overcrowding and allow future expansion.
4. **Principle of flexibility:** The layout should be adaptable to changes in product design, production volume, or process without major modifications.
5. **Principle of safety and comfort:** Proper working conditions, adequate lighting, ventilation, and safety provisions should be ensured to improve worker efficiency and reduce accidents.

12. Solution:

The elements of management are the key functions performed by managers to achieve organizational goals efficiently:

1. **Planning:** It is the process of deciding in advance the objectives to be achieved and the actions required to achieve them efficiently.
2. **Organizing:** Arranging resources and tasks to implement the plan effectively.
3. **Staffing:** Recruiting, training, and maintaining a competent workforce.
4. **Directing/Leading:** Guiding and motivating employees to achieve objectives.
5. **Controlling:** Monitoring performance and taking corrective actions when needed.

13. Solution:

Labour Legislation refers to the body of laws, rules, and regulations enacted by the government to protect the rights of workers, regulate working conditions, and ensure fair treatment in employment.

Importance of Labour Legislation:

1. **Protects workers' rights:** Ensures fair wages, working hours, and safe working conditions.
2. **Prevents exploitation:** Regulates child labor, bonded labor, and unfair dismissal.
3. **Maintains industrial peace:** Provides mechanisms for dispute resolution between employers and employees.
4. **Promotes social justice:** Ensures equal opportunities and welfare measures for workers.
5. **Regulates employment terms:** Covers aspects like leave, bonuses, provident fund, and maternity benefits.

14. Solution:

Given: C_o = Rs. 15 per order, D = 12000 units, Raw material cost = Rs. 1.25 per unit, C_h = 5% of average inventory, Lead time = 14 days, Safety stock = 400 units.

1. Economic order quantity,

$$\text{EOQ} = \sqrt{\frac{2C_oD}{C_h}} = \sqrt{\frac{2\times15\times12000}{\frac{5}{100}\times1.25}} = 2400 \text{ units}$$

2. Reorder level = Safety stock + Consumption during normal lead time

$$= 400 + 14\times\frac{12000}{300} = 960 \text{ units}$$

15. Solution:

Given: $\lambda = \frac{15}{8\times60} = \frac{1}{32}, \mu = \frac{1}{20}$ units/minute,

Number of hours for which the repairman remains busy in an 8-hour days,

$$= 8\times\frac{\lambda}{\mu} = 8\times\frac{\frac{1}{32}}{\frac{1}{20}} = 8\times\frac{20}{32} = 5 \text{ hours}$$

Therefore, time for which repairman remains idle in an 8-hour day,

= 8 – 5 = 3 hours or 180 minutes.

16. Solution:

Quality Control (QC) is the process of monitoring, inspecting, and testing products or services to ensure they meet the desired standards and specifications. It aims to detect and correct defects to maintain consistent quality.

Objectives of Quality Control:

1. **Ensure product quality:** Maintain products or services at required standards.
2. **Minimize defects and errors:** Identify and correct issues before products reach customers.
3. **Customer satisfaction:** Deliver reliable and high-quality products to meet customer expectations.
4. **Reduce production cost:** Avoid waste and rework due to defective products.
5. **Continuous improvement:** Enhance processes and quality through systematic monitoring and feedback.

17. Solution:

Work Sampling: Work sampling is a statistical technique used to estimate the proportion time spent by workers or machines on various activities by making random observations over a period of time, rather than continuous monitoring.

Advantages of Work Sampling :

1. Economical
2. Less disruptive
3. Wide applicability
4. Time-saving
5. Flexible

Limitations of Work Sampling:

1. Less accurate
2. Not suitable for short-cycle jobs
3. Requires skilled sampling
4. Cannot measure detailed operations
5. Assumes random behavior

18. Solution:

Value Analysis (VA): Value Analysis is a systematic approach aimed at improving the value of a product or process by analyzing its functions and cost. The main goal is to achieve the required function at the lowest total cost without compromising quality, reliability, or performance.

Key Points:

1. Focuses on functionality rather than just cost reduction.
2. Helps in identifying and eliminating unnecessary expenses in materials, design, and production processes.
3. Encourages creative problem-solving and alternative solutions.
4. Enhances product quality and customer satisfaction while reducing production cost.
5. Applied at design stage or during production to optimize product value.

19. Solution:

Let, Product 'A' = x

Product 'B' = y

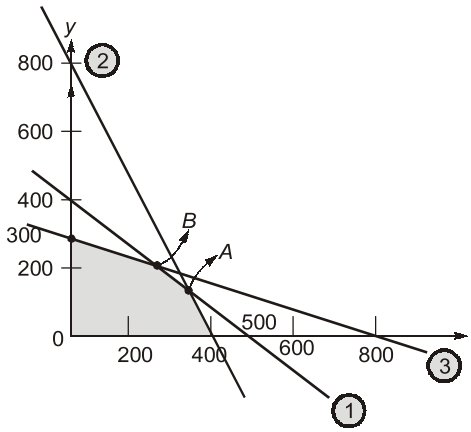
(i) Profit, $z = 120x + 100y$

Constraints, $2x + 2.5y \le 1000$... (i)

$3x + 1.5y \le 1200$... (ii)

$1.5x + 4.0y \le 1200$... (iii)

$x, y \ge 0$



(ii)
$$\frac{x}{500}+\frac{y}{400} \le 1$$
$$\frac{x}{400}+\frac{y}{800} \le 1$$
$$\frac{x}{800}+\frac{y}{300} \le 1$$

From equations (i) and (ii),

$$\Rightarrow \quad x = \frac{1000}{3}, \quad y = \frac{400}{3} \text{ (Point } A\text{)}$$

From equations (i) and (iii),

$$7x = \frac{4000}{17}, \quad y = \frac{3600}{17} \text{ (Point } B\text{)}$$

or
$$A = \left(\frac{1000}{3}, \frac{400}{3}\right), \text{ In integer form (333, 133)}$$
$$B = (235, 211)$$
$$Z_A = (120 \times 333 + 100 \times 133) = 53260 \text{ - Optimum profit.}$$
$$Z_B = (120 \times 235 + 100 \times 211) = 49300$$

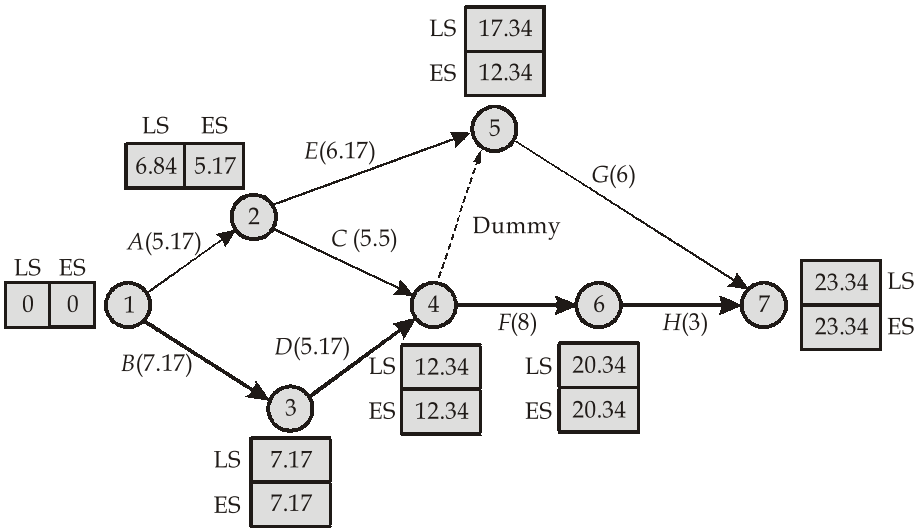
For maximum profit quantities of products required to be produced are

Product A: 333 units

Product B: 133 units

20. Solution:

(i)



(ii)

Activity	Expected time (t_e)	Variance (σ^2)
A	5.17	0.69
B	7.17	0.25
C	5.5	0.69
D	5.17	0.69
E	6.17	0.69
F	8	1
G	6	1
H	3	1.78

As $$t_e = \frac{t_0 + t_p + 4t_m}{6}$$

and $$\sigma^2 = \frac{(t_P - t_o)^2}{36}$$

(iii) Critical path: $1 \rightarrow 3 \rightarrow 4 \rightarrow 6 \rightarrow 7$

i.e. *B*, *D*, *F* and *H* are critical activities.

Expected project completion time, $t_{cp} = 7.17 + 5.17 + 8 + 3 = 23.34$

(iv) $$\sigma^2_{cp} = \sigma^2_B + \sigma^2_D + \sigma^2_F + \sigma^2_H = 3.72 \quad \Rightarrow \sigma_{cp} = 1.93$$

$\therefore$ $$z = \frac{T - t_{cp}}{\sigma_{cp}} = \frac{30 - 23.34}{1.93} = 3.45$$

$\therefore$ $$P(3.45) = 0.99972 \text{ or } 99.972\%$$

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