CLASS TEST

SL.: 01_SP_ME_A+C_160123

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INDUSTRIAL ENGINEERING

MECHANICAL ENGINEERING

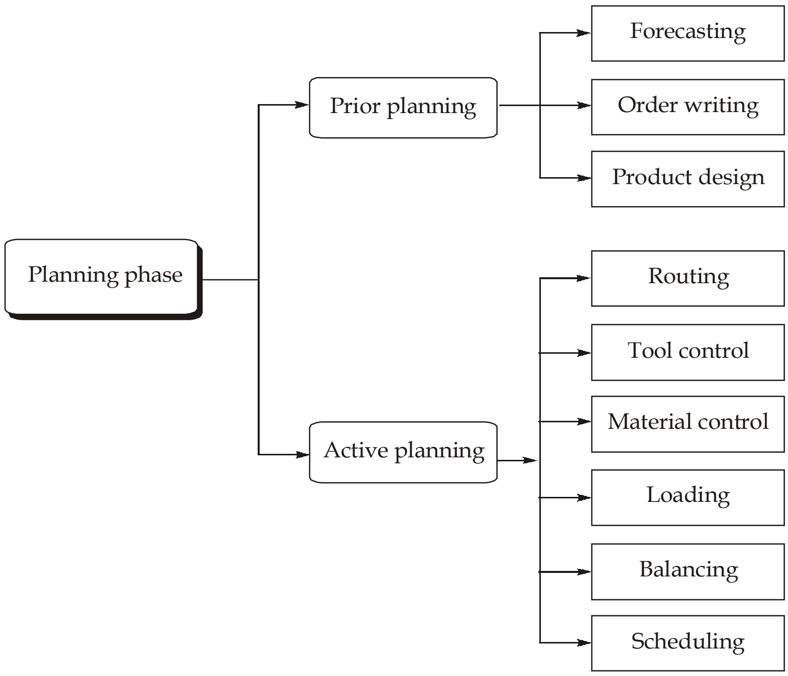
Date of Test : 16/01/2023

ANSWER KEY

1.	(d)	7.	(a)	13.	(b)	19.	(c)	25.	(d)
2.	(a)	8.	(b)	14.	(c)	20.	(a)	26.	(b)
3.	(c)	9.	(d)	15.	(c)	21.	(c)	27.	(c)
4.	(b)	10.	(a)	16.	(b)	22.	(a)	28.	(d)
5.	(b)	11.	(b)	17.	(d)	23.	(a)	29.	(a)
6.	(b)	12.	(c)	18.	(a)	24.	(a)	30.	(c)

DETAILED EXPLANATIONS

1. (d)



2. (a)

Responsiveness indicates that the forecast have fluctuating or swinging pattern. It is preferred for new product and for that number of period is kept small. Stability means that the forecast pattern is flat, smooth and has less fluctuation. It is preferred for old existing product and for that number of period is kept large.

$$\therefore \quad F_t = F_{t-1} + \alpha(D_{t-1} - F_{t-1})$$

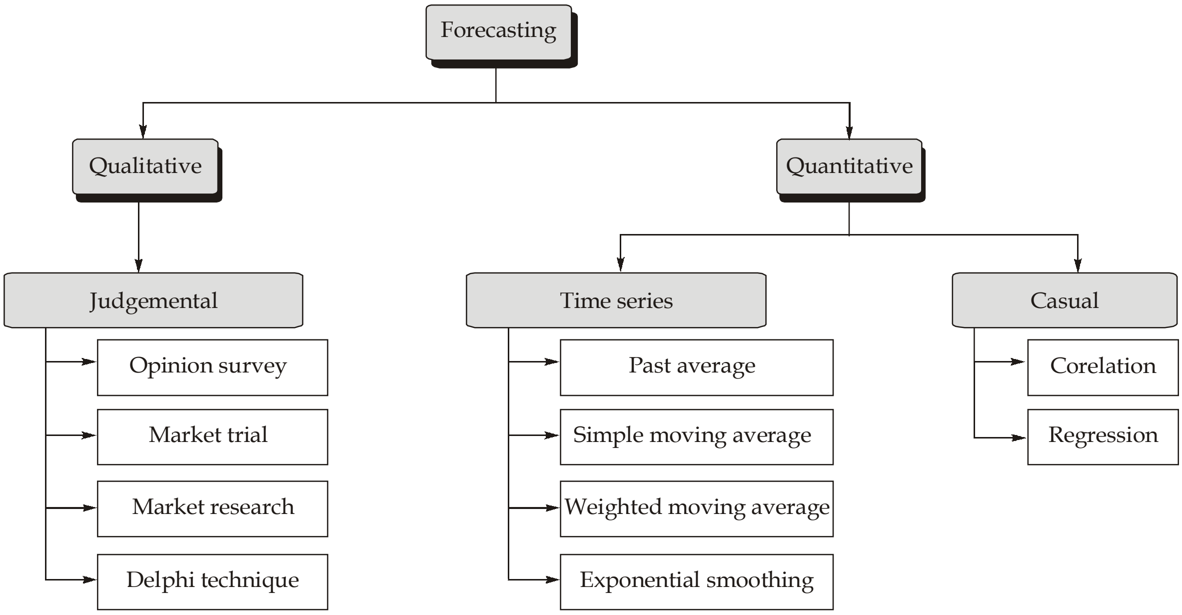
If $\alpha = 0$, $n \to \infty$ (limit of stability) $\qquad \left[\because \alpha = \dfrac{2}{n+1}, \text{if } \alpha \text{ is not given}\right]$

$$F_t = F_{t-1}$$

If $\alpha = 1$, $n = 1$ (Limit of responsiveness)

$$F_t = D_{t-1}$$

3. **(c)**



4. **(b)**

If all the values in the replacement ratio column are either negative or infinite then the solution terminates and it indicates that the simplex problem have unbounded solution.

6. **(b)**

$$\text{Break-even point units} = \frac{100000}{10-8} = 50000$$

$$\text{Capacity} = 80000$$

$$\text{Margin of safety} = 80000 - 50000 = 30000$$

7. **(a)**

$$\text{Expected demand} = 60 \times 0.17 + 65 \times 0.12 + 70 \times 0.25 + 80 \times 0.26 + 90 \times 0.2 = 74.3$$

8. **(b)**

$$EOQ = \sqrt{\frac{2DC_0}{C_h}}$$

$$(EOQ)_A = \sqrt{\frac{2\times200\times100}{8}}$$

$$(EOQ)_B = \sqrt{\frac{2\times800\times100}{2}} = 4 \times (\text{EOQ})_A$$

$$\Rightarrow \quad (EOQ)_A : (EOQ)_B :: 1 : 4$$

9. (d)

As $$x_{BEP} = \frac{F}{s-v}$$

$$\Rightarrow \quad 3500 = \frac{14000}{7-v}$$

$$7 - v = 4,$$

$$v = ₹\,3 \text{ per unit}$$

11. (b)

Given: $D_1 = 180$ unit, $F_1 = 200$ units

We know that, $F_2 = F_1 + \alpha(D_1 - F_1)$

$= 200 + 0.4(180 - 200) = 192$ units

$F_3 = F_2 + \alpha(D_2 - F_2)$

$= 192 + 0.4(210 - 192) = 199.2$ unis

$F_4 = F_3 + \alpha(D_3 - F_3)$

$= 199.2 + 0.4(250 - 199.2)$

$F_4 = 219.52$ units

12. (c)

As per SPT rule:

Jobs	Processing time	Due date	Job flow time
A	5	11	5
C	9	13	14
E	11	26	25
B	13	19	38
D	16	31	54

$$\text{Average job flow time using SPT rule} = \frac{5+14+25+38+54}{5} = 27.2$$

As per EDD rule:

Jobs	Processing time	Due date	Job flow time
A	5	11	5
C	9	13	14
B	13	19	27
E	11	26	38
D	16	31	54

$$\text{Average job flow time using EDD rule} = \frac{5+14+27+38+54}{5} = 27.6$$

$$\text{Now, } \frac{\text{Avg. job flow time using SPT}}{\text{Avg. job flow time using EDD}} = \frac{27.2}{27.6} \simeq 0.98$$

13. (b)

$D = 50000\ C_0 = ₹25,\ C_u = ₹40,\ C_h = 0.1 \text{ of } C_u = 0.1 \times 40 = ₹4$

$$EOQ = \sqrt{\frac{2DC_0}{C_h}} = \sqrt{\frac{2 \times 50000 \times 25}{4}} = 790.569 \text{ units}$$

$\because$ EOQ > Maximum quantity that can be ordered at ones.

So, $$(TIC)_{Q\,=\,600} = \frac{D}{Q} \times C_0 + \frac{Q}{2} \times C_h = \frac{50000}{600} \times 25 + \frac{600}{2} \times (40 \times 0.1)$$

$$= ₹3283.33$$

Alternate:

$$TIC = \frac{\sqrt{2DC_0C_h}}{2}\left[k + \frac{1}{k}\right] \qquad \left\{k = \frac{Q^*}{Q}\right\}$$

$$= \frac{\sqrt{2 \times 50000 \times 25 \times 4}}{2}[1.317615 + 0.758947]$$

$$TIC = ₹3283.33$$

14. (c)

$$\text{Arrival rate, } \lambda = \frac{1}{9} \text{ per minute}$$

$$\text{Service rate, } \mu = \frac{1}{5} \text{ per minute}$$

$$\text{Time in queue, } T = 10 \text{ minute}$$

$$\rho = \frac{\lambda}{\mu} = \frac{1/9}{1/5} = \frac{5}{9}$$

Probability (waiting time in queue > 10 minutes) = $\rho(\exp)^{-T/W_s}$

where, W_s is waiting time is system.

$$W_s = \left(\frac{\rho}{1-\rho}\right) \times \frac{1}{\lambda} = \left(\frac{5/9}{1-5/9}\right) \times 9$$

$$W_s = \frac{5 \times 9}{4} = \frac{45}{4} \text{ minutes}$$

Probability (W_q > 10 minutes) = $\left(\frac{5}{9}\right)(\exp)^{\frac{-10\times4}{45}}$ = 0.22839

Probability (W_q > 10 minutes) $\simeq$ 22.84%

15. (c)

Estimated completion time, T_e = 3 + 8 + 6 = 17

$$\text{Standard deviation, } \sigma = \sqrt{\Sigma\sigma^2} = \sqrt{1^2 + 2^2 + 2^2} = 3$$

$$z = \frac{T - T_e}{\sigma} = \frac{20-17}{3} = 1$$

$$\text{Probability} = 0.84$$

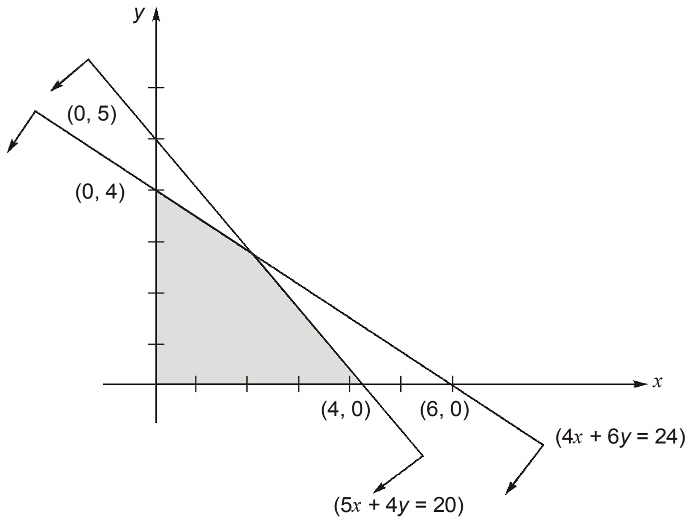
16. **(b)**

$P = 100$, $d = 75$, C_s = ₹ 600, C_h = ₹ 1

$$EOQ = \sqrt{\frac{2 \times C_s \times d}{C_h}} \times \sqrt{\frac{P}{P-d}} = \sqrt{\frac{2 \times 600 \times 75}{1}}\sqrt{\frac{100}{25}} = 600$$

17. **(d)**

Objective function is parallel to one of the binding constraints.



18. **(a)**

$$\text{S.I.} = \sqrt{\sum_{i=1}^{n}\left((T_s)_{\max} - T_{si}\right)^2}$$

$$(T_{si})_{\max} = 10 \text{ min}$$

$$\text{S.I.} = \sqrt{(10-6)^2 + (10-10)^2 + (10-8)^2 + (10-7)^2 + (10-6)^2 + (10-8)^2}$$

$$= \sqrt{4^2 + 2^2 + 3^2 + 4^2 + 2^2}$$

$$= \sqrt{16+4+9+16+4} = \sqrt{49} = 7$$

19. **(c)**

$$R_{eq} = [1 - (1 - R_3)(1 - R_1R_2)] \times R_4 \times R_5$$

$$= [1 - (1 - 0.7)(1 - 0.5 \times 0.6)] \times 0.8 \times 0.9$$

$$= 0.79 \times 0.8 \times 0.9$$

$$= 0.5688 = 56.88\%$$

20. (a)

$$\text{Variance } \sigma^2 = \left(\frac{t_p - t_0}{6}\right)^2$$

$$\text{Variance for activity } A,\ \sigma_A{}^2 = \left(\frac{3-1}{6}\right)^2 = 0.11111$$

$$\text{Variance for activity } B,\ \sigma_B{}^2 = \left(\frac{5-2}{6}\right)^2 = 0.25$$

$$\text{Standard deviation for project} = \sqrt{\sigma_A^2 + \sigma_B^2} = \sqrt{0.111 + 0.25} = 0.6$$

21. (c)

Given:

$$\text{O.T.} = 0.5 \text{ min}$$

$$R = 110\% = 1.1$$

$$\text{Allowances} = 10\% \text{ of standard time}$$

$$\text{Normal time, N.T.} = \text{O.T.} \times R = 0.5 \times 1.1$$

$$= 0.55 \text{ min}$$

$$\text{Standard time, S.T.} = \text{N.T.} + \text{Allowance}$$

$$\text{S.T.} = 0.55 + (0.1 \times \text{S.T.})$$

$$0.9 \text{ S.T.} = 0.55$$

$$\text{S.T.} = \mathbf{0.611 \text{ min}}$$

22. (a)

Sequence → D - C - B - A

Job	Job Time	Due Date	Job flow time
D	6	17	0 + 6 = 6
C	7	15	6 + 7 = 13
B	10	16	13 + 10 = 23
A	14	20	23 + 14 = 37

$\because$ Make span time = 37 days

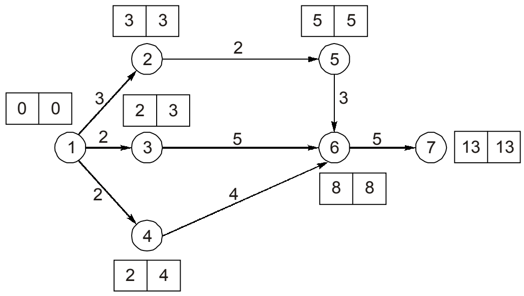
23. (a)

Distribution centres

Plants	1	2	3	4	Supply
1	2 (6)	3	11	7	6/0
2	1 (1)	0 (0)	6	1	1/0
3	5	8 (5)	15 (3)	9 (2)	10/5/2/0
Requirement	7/1/0	5/0	3/0	2/0	

$$\text{Minimum cost} = [2 \times 6 + 1 \times 1 + 8 \times 5 + 15 \times 3 + 9 \times 2] \times 100 = \text{Rs. } 11600$$

24. (a)



Critical path is 1 – 2 – 5 – 6 – 7

Project duration, t_E = 3 + 2 + 3 + 5 = 13

Free float (4 – 6) = 8 – 4 – 2 = 2

25. (d)

Given: LT = 3 months

d = 15 units

σ = 3 units

z = 0.97

Safety stock (ss) = $z \cdot \sigma = 0.97 \times 3 = 2.91$

ROL = $LT \times d + ss = 3 \times 15 + 2.91 =$ **47.91 units**

26. (b)

Arrival rate (λ) = 5/hour

Service rate (μ) = 6/hour

$$\rho = \frac{\lambda}{\mu} = \frac{5}{6} = 0.833$$

P(no queue) = P(0 person in system) + P(1 person in system)

$= P_0 + P_1$

$= P_0 + \rho P_0 = P_0(1+\rho) = 1 - \rho^2$

$= 0.305$

28. (d)

We know that,

$$\left(\frac{P}{V}\right)_{\text{ratio}} = \frac{(S-V)}{S} \times 100\% = \frac{(1000000 - 650000)}{1000000} \times 100\%$$

$= 35\%$

$$\text{BEP} = \frac{\text{Fixed cost}}{\left(\frac{P}{V}\right)_{\text{ratio}}} = \frac{90000}{0.35} = ₹257142.86$$

$(\text{BEP})_{\text{sales}} \approx ₹257143$

29. (a)

$$\text{Total time} = 15 + 10 + 12 + 13 + 15 + 9 = 74$$
$$\text{Cycle time} = 15$$
$$\text{Line efficiency} = \frac{\text{Total time}}{\text{Cycle time} \times \text{No. of work station}} = \frac{74}{15 \times 6} \simeq 82\%$$

30. (c)

For 200 units of A.

$$\text{Units of } P = 2 \times 200 = 400 \text{ units}$$
$$\text{Net requirement of } P = 400 - 20 = 380 \text{ units}$$

for 1 units of P, units of S required = 4

$$\text{Net requirement of } S = 4 \times 380 - 10 = 1520 - 10 = 1510 \text{ units}$$

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