CLASS TEST

SL.: 02SPME_HIJKL_10072024

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INDUSTRIAL ENGINEERING

MECHANICAL ENGINEERING

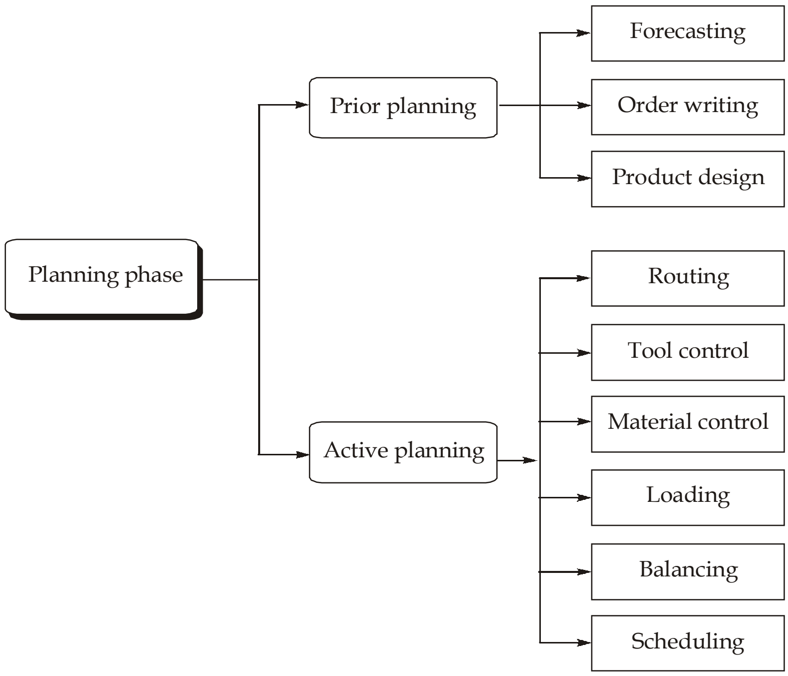
Date of Test : 10/07/2024

ANSWER KEY

1.	(d)	7.	(a)	13.	(b)	19.	(a)	25.	(d)
2.	(a)	8.	(b)	14.	(b)	20.	(a)	26.	(b)
3.	(c)	9.	(c)	15.	(c)	21.	(c)	27.	(b)
4.	(b)	10.	(a)	16.	(b)	22.	(b)	28.	(d)
5.	(d)	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.

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

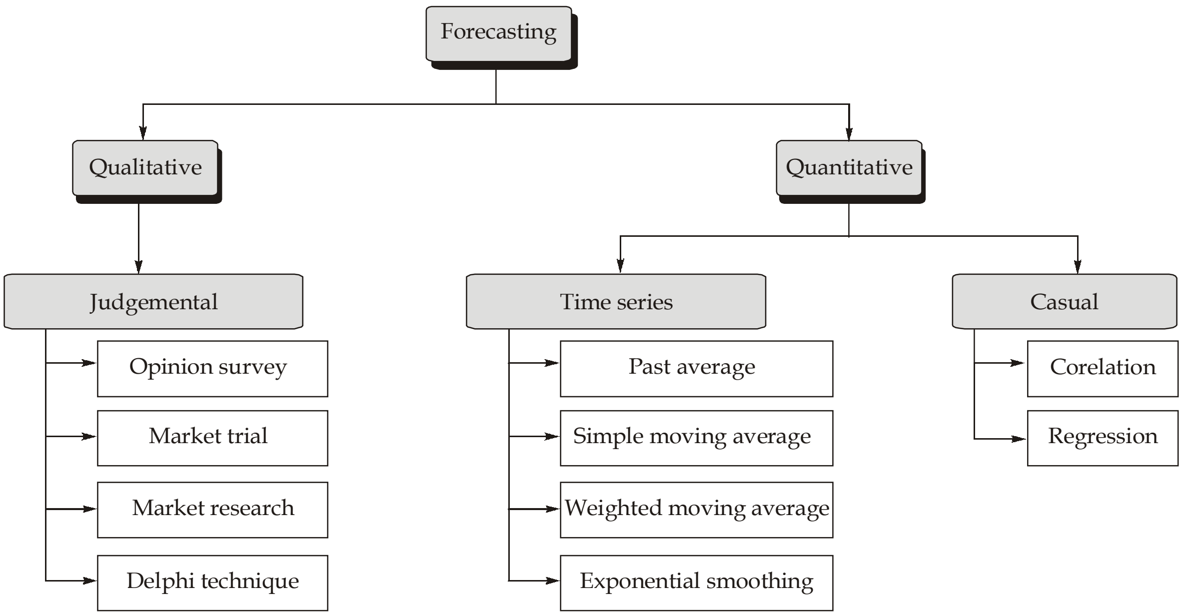
If $\alpha = 0$, $n \to \infty$ (limit of stability) $\quad \left[\because \alpha = \frac{2}{n+1}, \text{if } \alpha \text{ is not given}\right]$

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

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.

5. (d)

Total float (*TF*) denotes the amount of time by which an activity can be deleyed without delaying the project completion day.

$$TF = LFT_j - EST_i - t_{ij}$$

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)**

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

$$(EOQ)_A = \sqrt{\frac{2\times 200\times 100}{8}}$$

$$(EOQ)_B = \sqrt{\frac{2\times 800\times 100}{2}} = 4 \times (\text{EOQ})_A$$

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

9. (c)

Job	Machine A	Machine B
P	5	2
Q	1	6
R	9	7
S	3	8
T	10	4

Sequence Q - S - R - T - P

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)

To minimize time first apply row transaction (Subtract minimum time of row by other) we get

	M_1	M_2	M_3	M_4
J_1	2	0	1	4
J_2	0	1	4	2
J_3	3	2	~~0~~	1
J_4	1	3	0	2

Then apply column transaction (Subtract column minimum by others)

	M_1	M_2	M_3	M_4
J_1	2	[0]	1	3
J_2	[0]	1	4	1
J_3	3	2	0	[0]
J_4	1	3	[0]	1

So, $J_1 = M_2$, $J_2 = M_1$, $J_3 = M_4$, $J_4 = M_3$

14. (b)

$$\lambda = 6\text{/hour}$$
$$\mu = 8\text{/hour]}$$
$$\rho = \frac{\lambda}{\mu} = \frac{6}{8} = 0.75$$
$$L_q = \frac{\rho^2}{1-\rho} = \frac{0.75^2}{0.25} = 2.25 \text{ technicians}$$
$$W_q = \frac{L_q}{\lambda} = \frac{\rho^2}{(1-\rho)\lambda} = \frac{0.75^2}{0.25\times 6} = 22.5 \text{ minutes}$$
$$W_s = \frac{L_s}{\lambda} = \frac{\rho}{(1-\rho)\lambda} = \frac{0.75}{0.25\times 6} = 30 \text{ minutes}$$

Alternate: As $W_s > W_q$ always, only option (b) follow it.

15. (c)

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

$$\text{Standard deviation, } \sigma = \sqrt{\Sigma\sigma^2} = \sqrt{1^2 + 2^2 + 2^2} = 3$$
$$z = \frac{T - T_e}{\sigma} = \frac{20-17}{3} = 1$$
$$\text{Probability} = 0.84$$

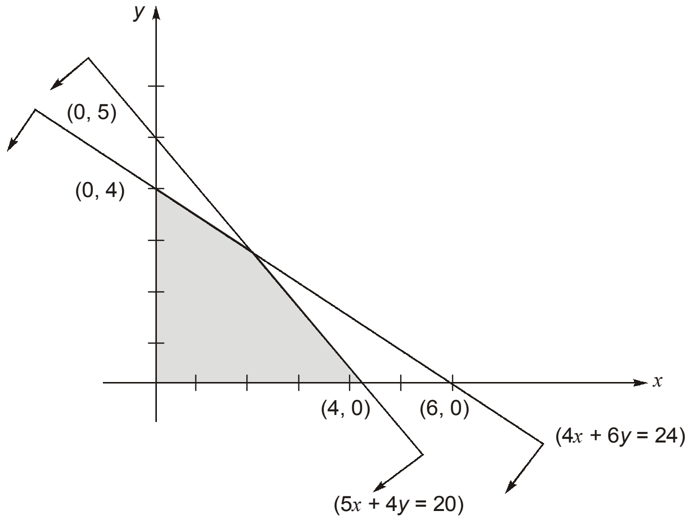
16. (b)

$P = 100$, $d = 75$, 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)

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

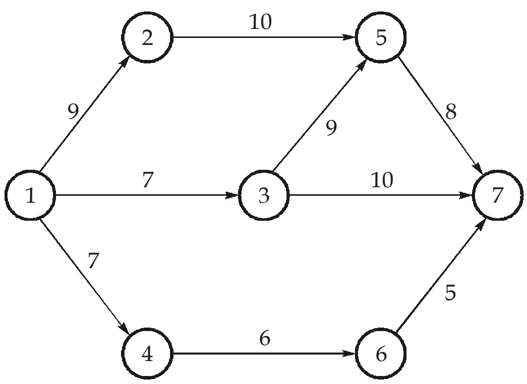
$$(T_{si})_{\max} = 10 \text{ min}$$

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

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

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

19. (a)



Activity	t_e
1 - 2	9
1 - 3	7
1 - 4	7
2 - 5	10
3 - 5	9
3 - 7	10
4 - 6	6
5 - 7	8
6 - 7	5

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

Paths

1 - 2 - 5 - 7 $\rightarrow$ 27

1 - 3 - 5 - 7 $\rightarrow$ 24

1 - 3 - 7 $\rightarrow$ 17

1 - 4 - 6 - 7 $\rightarrow$ 18

So, 27.

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: O.T. = 0.5 min

R = 110% = 1.1

Allowances = 10% of standard time

Normal time, N.T. = O.T. × R = 0.5 × 1.1

= 0.55 min

Standard time, S.T. = N.T. + Allowance

S.T. = 0.55 + (0.1 × S.T.)

0.9 S.T. = 0.55

S.T. = **0.611 min**

22. (b)

C_0 = 60 per order

For order size greater than 100

$$EOQ = \sqrt{\frac{2DC_0}{C_h}} = \sqrt{\frac{2 \times 1000 \times 60}{100 \times 0.1}} = 109.54$$

as *EOQ* is falling under assumed range i.e. greater than 100, it will be optimum size.

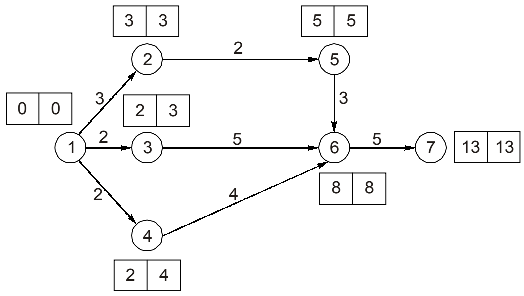
23. (a)

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	

Minimum cost = [2 × 6 + 1 × 1 + 8 × 5 + 15 × 3 + 9 × 2] × 100 = 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:

$$\text{LT} = 3 \text{ months}$$
$$d = 15 \text{ units}$$
$$\sigma = 3 \text{ units}$$
$$z = 0.97$$
$$\text{Safety stock (ss)} = z \cdot \sigma = 0.97 \times 3 = 2.91$$
$$\text{ROL} = LT \times d + ss = 3 \times 15 + 2.91 = \mathbf{47.91 \text{ units}}$$

26. **(b)**

$$\text{Arrival rate } (\lambda) = 5/\text{hour}$$
$$\text{Service rate } (\mu) = 6/\text{hour}$$
$$\rho = \frac{\lambda}{\mu} = \frac{5}{6} = 0.833$$
$$P(\text{no queue}) = P(0 \text{ person in system}) + P(1 \text{ person in system}) = P_0 + P_1$$
$$= P_0 + \rho P_0 = P_0(1 + \rho) = 1 - \rho^2 = 0.305$$

27. **(b)**

$$\text{TF} = \text{LFT} - \text{EFT} = 58 - 40 = 18$$
$$\text{FF} = \{\text{EFT} - \text{EST}\} - t_{ij} = 40 - 21 - 19 = 0$$
$$\text{IF} = \{E_j - L_i\} - t_{ij} = \{40 - 39\} - 19 = -18$$

Now

$$\text{FF} - \frac{\text{IF}}{\text{TF}} = 0 - \left\{-\frac{18}{18}\right\} = 1$$

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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