CLASS TEST

SL. : 01 SP_ME_ABC_15022024

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INDUSTRIAL ENGINEERING

MECHANICAL ENGINEERING

Date of Test : 15/02/2024

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (b)

For stable demand pattern, $\alpha \to 0$ and number of periods will be very large.

2. (d)

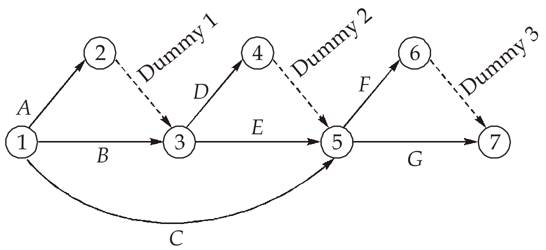
If all the values in the replacement ratio column are either negative or infinite then the solution terminates and it is the case of unbounded solution.

3. (b)

Buffer Inventory or Safety Stock : It is the minimum amount of inventory that is held throughout the year and it is held for protecting against the fluctuation in the demand rate and lead time.

11. (c)

Network diagram:



12. (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

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

13. (c)

Where,
D = Total demand
C = Cost per unit
C_h = Holding cost or carrying cost
C_0 = Ordering cost
Q^* = Quantity ordered at EOQ.

Given, Total worth = ₹100000

$D \times C$ = ₹100000

C_0 = 1.5% of $(Q^* \times C)$

C_h = 8% of C

$$Q^* = \sqrt{\frac{2DC_0}{C_h}} = \sqrt{\frac{2 \times \left(\frac{100000}{C}\right) \times \frac{1.5}{100} \times Q^* \times C}{\frac{8}{100} \times C}}$$

$$(Q^*)^2 = 37500 \times \frac{Q^*}{C}$$

$$(Q^* \times C) = ₹37500$$

14. (b)

$$\text{Total float} = L_j - (E_i + t_{Eij}) = 19 - (5 + 10) = 4$$
$$\text{Independent float} = E_j - (L_i + t_{Eij}) = 17 - (6 + 10) = 1$$
$$\text{T.F.} - \text{I.F.} = 4 - 1$$
$$\text{T.F} - \text{I.F.} = 3$$

15. (a)

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

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

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

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

16. (d)

$$\lambda = 10 \text{ hr}^{-1}$$
$$\mu = 15 \text{ hr}^{-1}$$
$$W_q = \frac{\lambda}{\mu(\mu - \lambda)} = \frac{10}{15 \times 5} \times 60 = 8 \text{ minutes}$$

17. (a)

Using SPT rule:

Jobs	Processing time	Due date	Job flow time
D	6	13	6
A	7	9	13
B	9	17	22
E	11	26	33
C	13	10	46

$$\text{Average job flow time} = \frac{46 + 33 + 22 + 13 + 6}{5} = \frac{120}{5} = 24$$

Using EDD Rule:

Jobs	Processing time	Due date	Job flow time
A	7	9	7
C	13	10	20
D	6	13	26
B	9	17	35
E	11	26	46

$$\text{Average job flow time} = \frac{7 + 20 + 26 + 35 + 46}{5} = 26.8$$

$$\frac{\text{Average job flow time using SPT rule}}{\text{Average job flow time using EDD rule}} = \frac{24}{26.8} = 0.895$$

18. (a)

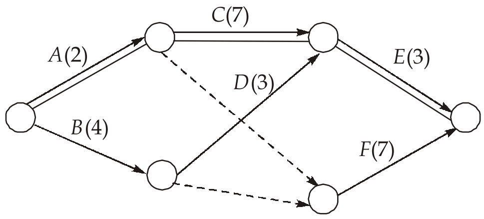
$$\text{Total time} = 15 + 10 + 12 + 13 + 15 + 9 = 74$$

$$\text{Cycle time} = 15$$

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

19. (c)

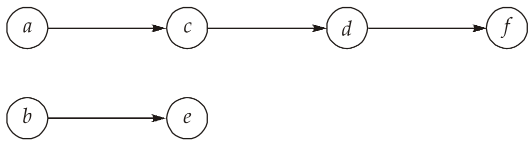
Drawing project network diagram.



Critical path $A - C - E$

$$\text{Time} = 2 + 7 + 3 = 12 \text{ days}$$

20. (c)



$$\text{Expected production rate} = 500 \text{ units per shift of 4 hour duration}$$

$$\text{Time to produce a unit} = \frac{4 \times 3600}{500} \text{seconds} = 28.8 \text{ seconds}$$

Station	Task	Station time
1	*a, c*	10 + 15 = 25 < 28.8
2	*b, d*	20 + 5 = 25 < 28.8
3	*e, f*	8 + 12 = 20 < 28.8

So, atleast we need 3 workstations.

Alternate solution:

$$\Sigma T_i = 10 + 20 + 15 + 5 + 8 + 72 = 70$$

$$\text{Time to produce a unit} = \frac{4 \times 3600}{500} = 28.8 \text{ seconds}$$

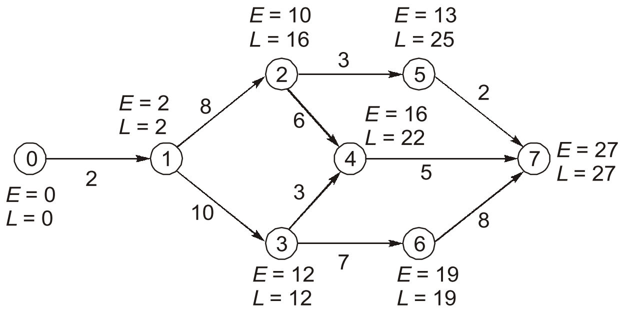
$$\text{Number of work-stations} = \frac{70}{28.8} = 2.43 \simeq 3 \text{ work-stations}$$

22. (b)

$$\text{Standard normal variate, } z = \frac{x - \bar{x}}{\sigma} = \frac{25 - 20}{5} = 1$$

$$P(1) = 0.842 \text{ or } 84.2\%$$

23. (a)



Activity	Duration	Start time		Finish time		Total float
		E	*L*	*E*	*L*	
0 – 1	2	0	0	2	2	0
1 – 2	8	2	8	10	16	6
1 – 3	10	2	2	12	12	0
2 – 4	6	10	16	16	22	6
2 – 5	3	10	22	13	25	12
3 – 4	3	12	19	15	22	7
3 – 6	7	12	12	19	19	0
4 – 7	5	16	22	21	27	6
5 – 7	2	13	25	15	27	12
6 – 7	8	19	19	27	27	0

24. (b)

Using Johnson's rule the optimal sequence is:
4 - 1 - 3 - 2 - 5 - 6

Job	Turning		Threading	
	In	Out	In	Out
4	0	2	2	8
1	2	5	8	16
3	5	10	16	25
2	10	22	25	35
5	22	31	35	38
6	31	42	42	43

Optimal MST = 43 min

25. (c)

$$F_{Feb} = F_{Jan} + \alpha[D_{Jan} - F_{Jan}]$$
$$= 12000 + 0.2\,[10000 - 12000] = 11600$$
$$F_{Mar} = F_{Feb} + \alpha[D_{Feb} - F_{Feb}]$$
$$= 11600 + 0.2[11000 - 11600] = 11480$$

26. (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	

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

27. (b)

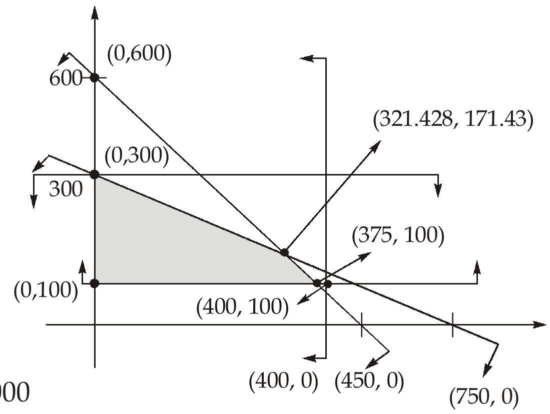
$$F_{\text{July}} = 0.1 \times D_{\text{Mar}} + 0.2 \times D_{\text{Apr}} + 0.3 \times D_{\text{Mar}} + 0.4 \times D_{\text{June}}$$

$$= 0.1 \times 300 + 0.2 \times 250 + 0.3 \times 310 + 0.4 \times 170 = 241$$

28. (b)

Profit, $Z = 30x + 40y$

$$1.6x + 1.2y \leq 720$$
$$1.2x + 3y \leq 900$$
$$x \leq 400$$
$$100 \leq y \leq 300$$
$$1.6x + 1.2y \leq 720$$
$$1.2x + 3y \leq 900$$
$$x = 321.428$$
$$y = 171.488$$
$$P_{(0,\,300)} = 30 \times 0 + 300 \times 40 = ₹12000$$
$$P_{(375,\,100)} = 375 \times 30 + 100 \times 40 = ₹15250$$
$$P_{(321.428,\,171.428)} = 321.428 \times 30 + 171.428 \times 40$$
$$= 16499.96 \simeq ₹16500$$



Point (400, 100) is outside of feasible region.

$$P_{(0,\,100)} = 30 \times 0 + 100 \times 40 = ₹4000$$

So, maximum profit is ₹ 16500.

29. (d)

Given: $D = 400$; $C = ₹\ 50$; $C_0 = ₹\ 75$; $C_h = 0.1 \times 50 = ₹\ 5$ per week

$$\text{Total cost} = D \times C + \sqrt{2 \times D \times C_0 \times C_h}$$

$$= 400 \times 50 + \sqrt{2 \times 400 \times 75 \times 5} = ₹\ 20547.72 \simeq ₹\ 20548$$

30. (c)

As per SPT, optimal sequence is

E – D – F – B – A – C

Respective completion time 3, 7, 12, 18, 25 and 33

Completion time for job A = 25 minutes

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