CLASS TEST

SL.: 01SKME_ABCDE_22032025

MADE EASY

Leading Institute for IES, GATE & PSUs

Delhi | Bhopal | Hyderabad | Jaipur | Pune | Kolkata

Web: www.madeeasy.in | **E-mail:** info@madeeasy.in | **Ph:** 011-45124612

INDUSTRIAL ENGINEERING

MECHANICAL ENGINEERING

Date of Test : 22/03/2025

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (a)

$$\lambda = 0.01 \text{ per hour}$$
$$T = 150 \text{ hours}$$
$$R = \exp^{(-\lambda t)} = e^{(-0.01 \times 150)} = 0.223130 = 22.31\%$$

2. (c)

$$p_a = 0.5034$$
$$p' = 0.01$$
$$\text{AOQ} = 0.5034 \times 0.01 \times \left(\frac{1000 - 25}{1000}\right)$$
$$= 0.490815 \times 10^{-2}$$
$$= 0.491\%$$

3. (c)

4. (b)

Cost saving after Value engineering = 1950 – 1660 = 290

$$\text{Annual saving} = 1320 \times 290 = 382800$$

5. (a)

$$\text{Incremental cost per day} = \frac{\text{Crash cost} - \text{Normal cost}}{\text{Normal time} - \text{Crash time}}$$
$$= \frac{700 - 500}{12 - 8} = \frac{200}{4} = 50$$

6. (a)

$$T_{ei} = \frac{a + 4m + b}{6}$$

a = Optimistic time, m = Most likely time, b = Pessimistic time

$$T_{ei} = \frac{4 + 4 \times 6 + 8}{6} = 6$$

$$\text{Variance} = \left(\frac{b - a}{b}\right)^2 = \left(\frac{8 - 4}{6}\right)^2 = 0.4445$$

$$\frac{T_{ei}}{\text{Variance}} = \frac{6}{0.4445} = 13.5$$

7. (c)

'$\in$' should be allocated to minimum cost cell, but it does not form a closed loop.
Firstly, it should be allocated to 2, but it forms a closed loop.
Hence, it is allocated to cost cell having transportation cost 7.

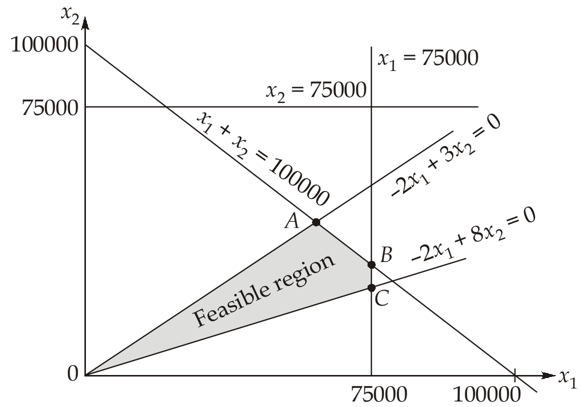
8. **(d)**

9. **(c)**

10. **(b)**

11. **(a)**

Unique solution



Point	x_1	x_2	z
0	0	0	0
A	60000	40000	14000
B	75000	25000	12500
C	75000	18750	11250

So, optimal solution is at A.

12. **(c)**

The given problem is maximization type converting it into minimization type.

	I	II	III	IV
A	20	70	50	0
B	60	100	70	80
C	30	25	30	20
D	40	45	60	30

Using Hungarian method.

	I	II	III	IV
A	20	70	50	0
B	0	40	10	20
C	10	5	10	0
D	10	15	30	0

	I	II	III	IV
A	20	65	40	0
B	0	35	0	20
C	10	0	0	0
D	10	10	20	0

	I	II	III	IV
A	10	55	30	0
B	0	35	0	30
C	10	0	0	10
D	0	0	10	0

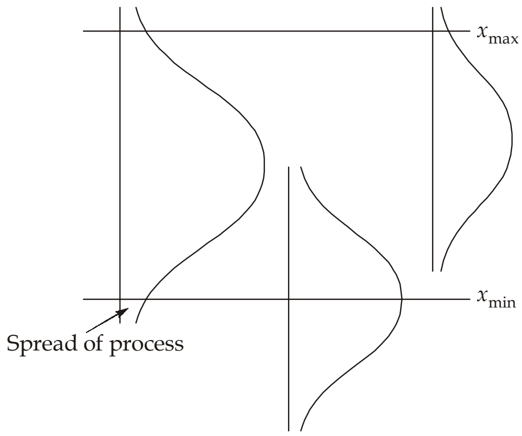
Sales men	Territory	Sales
A	IV	220
B	III	160
C	II	190
D	I	175
		745

This is a case of multiple optimal solution. Alternate optimal solution is

Sales men	Territory	Sales
A	IV	220
B	III	150
C	II	195
D	I	180
		745

13. (b)

$$\text{Spread of process} = 6\sigma'$$
$$\text{Specified tolerance} = X_{max} - X_{min}$$



Defective parts will be always there so, rejections are high.

14. (a)

$$IF_{ij} = \text{Max}\,\{0, ES_{jk} - LF_{ni} - t_{ij}\}$$

15. (b)

The allocation of units using north west corner rule is

		Warehouse		
	D	E	F	Supply
A	6(20)	4(30)	1	50
Plant B	3	8(40)	7	40
C	4	4(25)	2(35)	60
Demand	20	95	35	

16. (a)

$$\text{Demand} = D = 10000 \text{ units/year}$$
$$\text{Ordering cost} = C_o = ₹\,10/\text{order}$$
$$\text{Unit price} = C = ₹\,20/\text{unit}$$
$$\text{Holding cost} = C_h = 0.2 \times C = ₹\,0.2 \times 20 = ₹\,4/\text{unit/year}$$
$$\text{Back order cost} = c_b = 0.25 \times C = ₹\,0.25 \times 20 = ₹\,5/\text{unit/year}$$

$$Q_o = \sqrt{\frac{2DC_o}{C_h}}\sqrt{\frac{C_h + C_b}{C_b}} = \sqrt{\frac{2 \times 10000 \times 10}{4}}\sqrt{\frac{4+5}{5}} = 300 \text{ units/order}$$

Maximum quantity to be back-ordered = $S_o = Q_o - M_o$

where $$M_o = \sqrt{\frac{2DC_o}{C_h}}\sqrt{\frac{C_b}{C_h + C_b}} = \sqrt{\frac{2 \times 10000 \times 10}{4}}\sqrt{\frac{5}{4+5}} = 167 \text{ units}$$

$$S_o = 300 - 167 = 133 \text{ units}$$

17. (b)

	Fixed cost (₹)	Hourly cost of operating machine (₹)	Time to setup machine (minute)	Time per piece (minute)
Alternate-I	100000	100	30	4
Alternate-I	290000	500	45	0.2

Number of units produce in 1 hour

$$\text{For alternate I} = \frac{60}{4} = 15$$

$$\text{Cost per piece} = \frac{100}{15} = ₹6.667$$

$$\text{For alternate II} = \frac{60}{0.2} = 300$$

$$\text{Cost per piece} = \frac{500}{300} = ₹1.667$$

Set up cost alternate I:

$$100 \times \frac{30}{60} = ₹50$$

Set up cost alternate II:

$$500 \times \frac{45}{60} = ₹375$$

$(\text{Fixed cost + Variable cost})_{\text{alternate-I}} = (\text{Fixed cost + Variable cost})_{\text{alternate-II}}$

Let x be the minimum quantity.

$$100000 + 50 + 6.667x = 290000 + 375 + 1.667x$$
$$100050 + 6.667x = 290375 + 1.667x$$
$$5x = 190325$$
$$x = 38065 \text{ units}$$

Above 38065 units alternate II will be cheaper.

18. (b)

Weighted score for location 1 = 25 × 3 + 25 × 4 + 25 × 3 + 15 × 1 + 10 × 5

= 75 + 100 + 75 + 15 + 50 = 315

Weighted score for location 2 = 25 × 5 + 25 × 3 + 25 × 3 + 15 × 2 + 10 × 3

= 125 + 75 + 75 + 30 + 30 = 335

Since weighted score of location 2 is more so it is best.

19. (b)

Plotting the break even point.

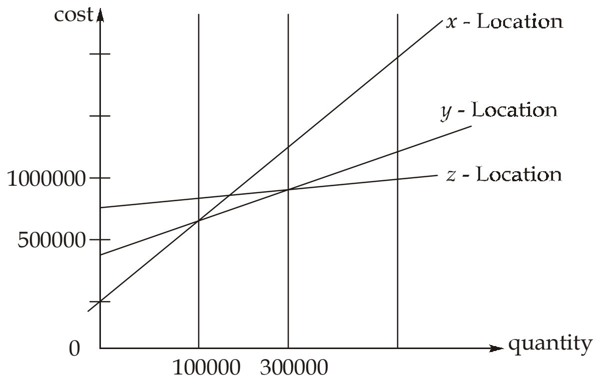
Solving for cross over between x and y,

$$10q + 150000 = 8q + 350000$$
$$q = 100000 \text{ units}$$

Solve for cross over between y and z

$$8q + 350000 = 6q + 950000$$
$$q = 300000 \text{ units}$$

From graph for 130000 units y is best location.



20. (a)

p_i = Probability of failure of bulb in i^{th} week

$p_0 = 0,$ $p_1 = 0.1,$

$p_2 = 0.2,$ $p_3 = 0.4,$

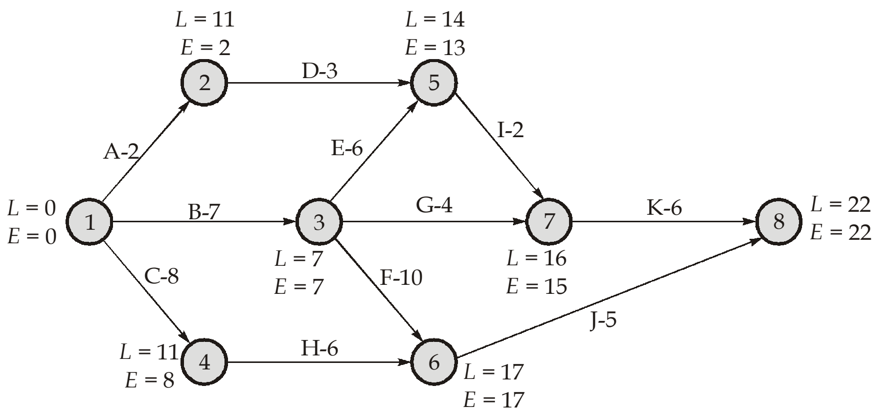
$p_4 = 0.3$

$$\text{Average life of bulb} = \sum_{i=1}^{4} ip_i = 1 \times 0.1 + 2 \times 0.2 + 3 \times 0.4 + 4 \times 0.3 = 2.9 \text{ weeks}$$

$$\text{Average number of failures} = \frac{300}{2.9} = 103.4482 \approx 103$$

Cost of individual replacement of bulb = 2 × 103 = ₹206 per week.

21. (a)



Free float for G is 15 – 11 = 4

Independent float for G is 15 – 7 – 4 = 4

Difference = 4 – 4 = 0

22. (a)

Setting the problem in standard form,

Maximize, $w = 0x_1 + 0x_2 + 0x_3 + 0s_1 + 0s_2 + A_1 + A_2$

Subject to, $3x_1 + 2x_2 + x_3 + 4x_4 + s_1 = 6$

$2x_1 + x_2 + 5x_3 + x_4 + s_2 = 4$

$2x_1 + 6x_2 - 4x_3 + 8x_4 + A_1 = 0$

$x_1 + 3x_2 - 2x_3 + 4x_4 + A_2 = 0$

$x_1, x_2, x_3, x_4, s_1, s_2, A_1, A_2 \geq 0$

For finding the basic feasible solution,

$x_1 = x_2 = x_3 = x_4 = 0,$

$s_1 = 6, \quad s_2 = 4,$

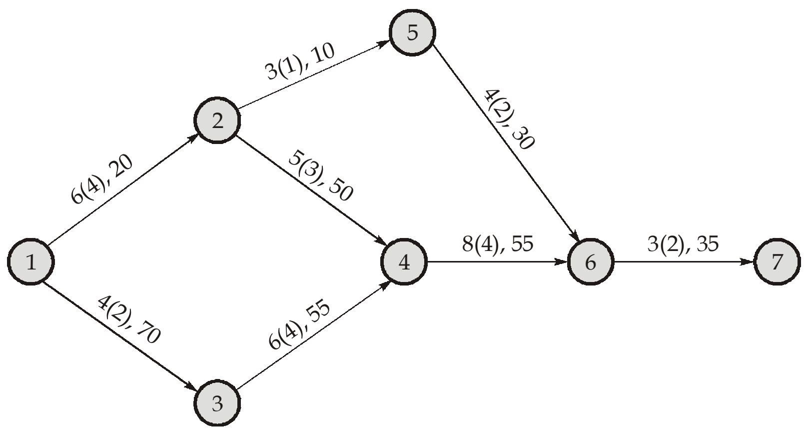
$A_1 = 0, \quad A_2 = 0$

$w = 0$

Since, w = 0 and A_1 and A_2 = 0, so phase I is not required and we can solve directly phase II and LPP has feasible solution.

Constraints 4 is half of constraint 3 so, it shows the presence of redundancy in constraints.

23. (c)



Activity	1 – 2	1 – 3	2 – 4	2 – 5	3 – 4	4 – 6	5 – 6	6 – 7
Crash cost/ day	20	70	50	10	55	55	30	35

Critical path is 1 - 2 - 4 - 6 - 7

Normal duration = 22 days

To crash project by 1 day, we crash activity 1 - 2, as it has minimum cost of crashing.

Cost of crashing = 20

Direct cost = 470

Indirect cost = 10 × 21 = 210

Total cost = 700

24. (a)

Period	Actual demand (D)	F	$F_t = F_{t-1} + \alpha[(D_{t-1}) - (F_{t-1})]$
1	10	10	10
2	12	10	$10 + 0.3 \times (10 - 10) = 10$
3	8	10.6	$10 + 0.3(12 - 10) = 10.6$
4	11	9.82	$10.6 + 0.3(8 - 10.6) = 9.82$
5	9	10.174	$9082 + 0.3(11 - 9.82) = 10.174$

25. (a)

$$\lambda = 6 \text{ cust/hr}, \qquad t = 30 \text{ min} = 0.5 \text{ hr}$$

$$n = 4,$$

$$\lambda t = 6 \times 0.5 = 3$$

$$\text{Probability} = \frac{(\lambda t)^n \cdot e^{-\lambda t}}{n!} = \frac{(3)^4 \cdot e^{-3}}{4!} = 0.168$$

26. (c)

$$\text{Weekly demand, } R = 400 \text{ units/week}$$

$$\text{Ordering cost, } C_3 = ₹75 \text{ per order}$$

$$\text{Carrying cost, } C_1 = 7.5\% \text{ per year of product cost}$$

$$C_1 = \left(\frac{7.5}{100} \times 50\right) \text{ per unit per year}$$

$$= \left(\frac{7.5}{100} \times \frac{50}{52}\right) \text{ per unit per week}$$

$$= \frac{3.75}{52} \text{ per unit per week}$$

$$\text{Total cost of inventory} = 400 \times 50 + \sqrt{2C_1C_3R}$$

$$= 400 \times 50 + \sqrt{2 \times \frac{3.75}{52} \times 75 \times 400}$$

$$= 20000 + 65.78 = ₹20065.78 \text{ per week}$$

$$\text{Profit} = 55 \times 400 - 20065.78 = ₹1934.22$$

27. (b)

$$\text{Cycle time} = \frac{480}{20} = 24 \text{ minutes/ unit}$$

$$\text{Minimum number of workstation} = \frac{80}{24} = 3.22 \approx 4$$

$$\text{Balance efficiency} = \frac{80}{24 \times 4} \times 100 = 83.33\%$$

28. (c)

P, R, S are correct and Q is incorrect as objective function is measurable in quantitative terms.

29. (c)

According to shortest processing rule

Job	Processing time t_i (minutes)	Job flow time
4	3	3
1	4	7
3	6	13
2	8	21

$$\text{Total job flow time} = 3 + 7 + 13 + 21 = 45$$

$$\text{Mean flow time} = \frac{44}{4} = 11 \text{ minutes}$$

According to earliest due date rule

Job	Processing time	Job flow time
2	8	8
1	5	13
3	6	19
4	3	22

$$\text{Total job flow time} = 8 + 13 + 19 + 22 = 62$$

$$\text{Mean flow time} = \frac{62}{4} = 15.5$$

$$\text{Ratio} = \frac{11}{15.5} = 0.71$$

30. (c)

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

$$F_{14} = 75; \quad D_{14} = 100; \quad \alpha = 0.5$$

$$F_{15} = 75 + 0.5\ (100 - 75) = 87.5$$

$$F_{16} = 87.5 + 0.5\ (100 - 87.5) = 93.75$$

Now,

$$(\text{Error})_{14} = 25$$

$$(\text{Error})_{15} = 12.5$$

$$(\text{Error})_{16} = 6.25$$

$$\text{BIAS} = (\text{Mean forecast error})$$

$$= \frac{25 + 12.5 + 6.25}{3} = 14.583$$

■■■■