CLASS TEST

SL.: 02SKME_JKLM_24072025

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INDUSTRIAL ENGINEERING

MECHANICAL ENGINEERING

Date of Test : 24/07/2025

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (d)

2. (d)

We know that,

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

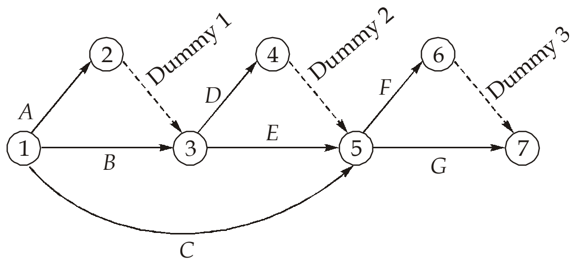
$$= 35\%$$

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

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

3. (b)

Network diagram:



4. (a)

$$\text{Labour productivity} = \frac{\text{Aggregate output}}{\text{Expenses on labour}} = \frac{9000}{16\times 350} = \frac{9000}{5600} = 1.607 \approx 1.61$$

5. (d)

In VED method inventories are classified on the basis of importance for the production system.

$V \rightarrow$ Vital

$E \rightarrow$ Essential

$D \rightarrow$ Desirable

6. (c)

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

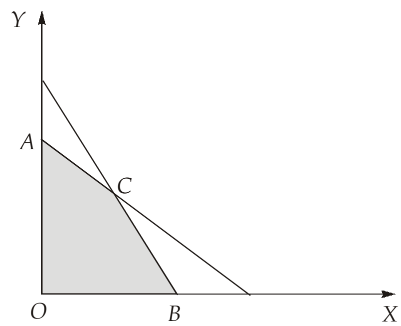
Given, Total worth = ₹100000
$D \times C$ = 100000
C_0 = 1.5% of ($Q^* \times C$)
C_h = 8% of C

$$Q^* = \sqrt{\frac{2DC_0}{C_h}} = \sqrt{\frac{2\times\left(\frac{100000}{C}\right)\times 1.5\times Q^*\times C\times 100}{100\times 8\times C}} = \sqrt{\frac{150000\times Q^*}{4\times C}}$$

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

$$(Q^*\times C) = ₹37500$$

7. (a)



Only point O, A, B and C will be considered in graphical method for optimal solution.

8. (b)

$$EOQ = \sqrt{\frac{2DC_0}{C_h}} = \sqrt{\frac{2\times 80\times 200}{0.05}} = 800 \text{ unit}$$

$$T^* = \frac{800}{80} = 10 \text{ days}$$

$\because$ Lead time $> T^*$

Then, Effective lead time $= LT - T^* = 15 - 10$

$= 5$ days

Reorder level (Demand during efficiency lead time) = (Effective lead time) × (Demand/day)

$= 5\times 80 = 400$ kg

9. (c)

Weekly standard deviation is σ.

Standard deviation σ' corresponding to lead time will be,

$$(\sigma')^2 = \sigma^2 + \sigma^2 + \sigma^2 + \sigma^2 + \sigma^2$$

$$\sigma' = (\sqrt{5})\sigma$$

For 95% service level,

($Z = 1.645$ for 95% service level)

$$\text{Safety stock, } SS = Z.\sigma' = 1.645\times\sqrt{5}\sigma = 3.6783\sigma$$

$$SS = 3.68\sigma$$

10. (a)

Primal	⇔	Dual
Maximize	⇒	Minimize
Coefficient of objective function	⇒	Constraints
Constraints	⇒	Coefficient of objective function

11. (d)

$$\text{MAD} = \frac{\sum_{i=1}^{n}|D_i - F_i|}{n} = \frac{\{|110-96|+|124-127|+|119-134|+|134-112|\}}{4}$$

$$= \frac{14+3+15+22}{4} = \frac{54}{4}$$

$$\text{RSFE} = \sum_{i=1}^{n}(D_i - F_i)$$

$$= (110 - 96) + (124 - 127) + (119 - 134) + (134 - 112)$$

$$= 14 - 3 - 15 + 22 = 18$$

$$\frac{\text{RSFE}}{\text{MAD}} = \frac{18}{(54/4)} = \frac{18\times4}{54} = 1.333$$

12. (a)

Minimum processing time on M_1 is = 7
Maximum processing time on M_2 is = 5
Maximum processing time on M_3 is = 6
Minimum processing time on M_4 is = 6
Minimum $M_{1j} \geq$ Maximum M_{2j}, Maximum M_{3j}
Minimum $M_{4j} \geq$ Maximum M_{2j}, Maximum M_{3j}
We can reduce this problem to n jobs on 2 machines. Processing times $M_{1j} + M_{2j} + M_{3j}$ and $M_{4j} + M_{2j} + M_{3j}$ for each job and solving the problem.

Combination of Machines \ Jobs	P	Q	R	S	T
$M_1 + M_2 + M_3$	18	20	12	15	19
$M_2 + M_3 + M_4$	20	21	14	9	15

R – P – Q – T – S
Hence the required optimum sequence is R – P – Q – T – S.

13. (b)

$$\text{S.I.} = \sqrt{\sum_{i=1}^{n}(\text{Max. station time} - \text{station time})^2}$$

$$\text{S.I.} = \sqrt{(12-12)^2 + (12-10)^2 + (12-11)^2 + (12-7)^2 + (12-t)^2}$$

$$\sqrt{39} = \sqrt{0+4+1+25+(12-t)^2}$$

Squaring on both side,

$$39 = 30 + (12 - t)^2$$

$$9 = (12 - t)^2$$

$$\pm3 = 12 - t$$

Taking (+) sign, $t = 12 - 3$

$t = 9$ minutes

Taking (–) sign, $t = 12 + 3 = 15$ minutes. Not feasible because max. station time is given in problem as 12 minutes.

14. (d)

Year(X)	Demand in 100 units(y)	Deviation of x from 2010(x)	x^2	xy
2007	85	–3	9	–255
2008	75	–2	4	–150
2009	80	–1	1	–80
2010	72	0	0	0
2011	65	1	1	65
2012	60	2	4	120
2013	55	3	9	165
$n = 7$	$\Sigma y = 492$	$\Sigma x = 0$	$\Sigma x^2 = 28$	$\Sigma xy = -135$

$$\Sigma y = \Sigma a + b\Sigma x$$

$$\Rightarrow \quad \Sigma y = na + b\Sigma x$$

$$\Rightarrow \quad 492 = 7 \times a + 0$$

$$\Rightarrow \quad a = 70.2857$$

$$\Sigma xy = \text{a}\Sigma x + b\Sigma x^2$$

$$\Rightarrow \quad -135 = 0 + b \times 28$$

$$\Rightarrow \quad b = -4.82143$$

Best line of fit, $y = a + bx = (70.2857 - 4.82143x)$

Demand in 2015 $= (70.2857 - 4.82143 \times 5) \times 100 = 4617.856$ units.

15. (d)

$$(\text{BEP})_1 = \frac{F_1}{(s-v)_1} = \frac{2700000}{(54-45)} = 300000$$

$$(\text{BEP})_2 = \frac{F_2}{(s-v)_2}$$

$\because$ (BEP) is same so, $(\text{BEP})_2 = 300000$

$$300000 = \frac{F_2}{(54 \times 1.12 - 45 \times 1.10)}$$

$$F_2 = ₹3294000$$

Profit = Sale – (F.C. + V.C.)

= 54 × 1.12 × 350000 – (3294000 + 1.1 × 45 × 350000)

Profit = ₹ 549000 = ₹ 5.49 lakh

16. (a)

Assigning elements to various work stations, we have the four work stations in the order given below:

	Work element	Station time
Work station I	*A, C*	1.0 min
Work station II	*B, D*	1.0 min
Work station III	*E, F, G*	0.9 min
Work station IV	*H, I*	1.0 min

n = No. of work station

$$\text{Balance delay} = 1 - \frac{TWC}{n \times T_c}$$

$$= 1 - \frac{3.9}{4 \times 1} = \frac{4 - 3.9}{4} = \frac{0.1}{4} = \frac{0.1 \times 100\%}{4} = 2.5\%$$

17. (a)

18. (d)

19. **(c)**

$$\text{Break even point} = \frac{\text{Total fixed expenses}}{(\text{Weighted average selling price} - \text{weighted average variable expenses})}$$

$$\text{Weighted average unit selling price} = \frac{300}{900} \times 5 + \frac{200}{900} \times 8 + \frac{400}{900} \times 7 = \text{Rs. } 6.556$$

$$\text{Weighted average unit variable expense} = \frac{300}{900} \times 2 + \frac{200}{900} \times 5 + \frac{400}{900} \times 4 = \text{Rs. } 3.566$$

$$\text{Break even point} = \frac{1200}{(6.556 - 3.556)} = 400 \text{ units}$$

Break even sale = 400 × (weighted average selling price)
= 400 × 6.556
= Rs. 2622.4 $\simeq$ Rs. 2620

20. **(b)**

We can clearly see from given options that margin of safety is in terms of cost.

So, MOS = Actual sale – sale at break even point

$= sx - sx_{BEP}$

$= s(x - x_{BEP})$

$= s\left(x - \frac{F}{s - v}\right)$ which is (a) option.

Similarly if we check for (c) and (d) option.

$$\frac{P}{PV\text{ ratio}} = \frac{sx - vx - F}{\left(\frac{s - v}{s}\right)} = s\left(x - \frac{F}{s - v}\right) = s(x - x_{BEP})$$

$$s\left(\frac{CM}{s - v} - \frac{F}{s - v}\right) = s\left(\frac{sx - vx}{s - v} - \frac{F}{s - v}\right)$$

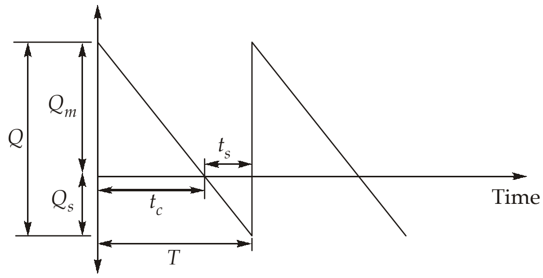
$= s(x - x_{BEP})$

21. (a)

Given, Stockout cost, C_s = Rs. 50 per item per year

Carrying cost, $C_h = \frac{5}{100}C_s = 0.05\ C_s$ = Rs. 5 per item per year

$EOQ,\ Q$ = 441 items



$$\text{Stockout cost} = \frac{Q_s}{2} \times \frac{t_s}{T} \times c_s$$

we know, $$\frac{Q_m}{Q_s} = \frac{C_s}{C_h}$$

$$\Rightarrow \quad Q_s = \frac{C_h Q}{C_s + C_h}$$

Also, $$\frac{t_m}{t_s} = \frac{Q_m}{Q_s} = \frac{C_s}{C_h}$$

$$\Rightarrow \quad t_s = \left(\frac{C_h}{C_s + C_h}\right) \times T$$

$$\Rightarrow \quad \text{Stock out cost} = \frac{1}{2}\left(\frac{C_h}{C_s + C_h}\right)^2 QC_s$$

$$= \frac{1}{2} \times \left(\frac{0.05}{1 + 0.05}\right)^2 \times 441 \times 50 = \frac{1}{2} \times \frac{5^2}{105^2} \times 441 \times 50$$

$$= \frac{1}{2} \times \frac{5^2}{(5 \times 21)^2} \times 21^2 \times 50 = \text{Rs. 25 per year}$$

22. (b)

Let P_n denote that there are n persons in the system, then $P_n = \rho^n(1 - \rho)$.

For atleast 2 persons in the queue, these must be atleast 3 persons in the system.

So,P(atleast 2 persons in the queue) $= 1 - P_0 - P_1 - P_2$

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

$$= 1-(1-\rho)\frac{(1-\rho^3)}{(1-\rho)} = \rho^3$$

23. (d)

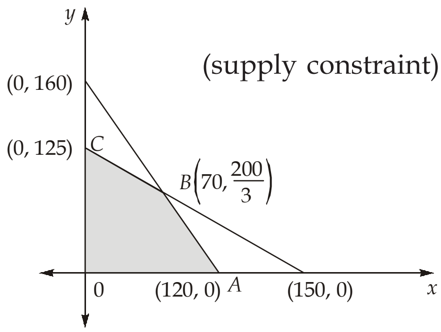
Let x and y be the units manufactured of chair and table respectively.

then $2x + 1.5y \le 8 \times 30$ (hour constraints)

$\Rightarrow \quad \frac{x}{120}+\frac{y}{160} \le 1$

also $50x + 60y \le 7500$ (supply constraint)

$\Rightarrow \quad \frac{x}{150}+\frac{y}{125} = 1$



Profit, Z = Rs.$(9x + 8y)$

$Z(O)$ = Rs.0

$Z(A)$ = Rs.1080

$$Z(B) = \text{Rs.}\left[(9\times 70)+\left(8\times\frac{200}{3}\right)\right] = \text{Rs.}1163.33$$

$Z(C)$ = Rs.(8×125)

= Rs. 1000

As Z(B) is maximum, maximum profit will be Rs 1163.33

24. (d)

For 'A' category item, low inventory is kept while for 'C' category item inventory is kept almost full.

25. (c)

26. (d)

Given, arrival rate, λ = 3 customers per hours

service rate, $\mu = \frac{60}{15}$ = 4 customers per hour

Using little's law,

Average length in queue = arrival rate × average waiting time in queue.

$\Rightarrow \quad L_q = \lambda \times W_q$ ...(1)

As $L_q = \frac{\rho^2}{1-\rho}$ (where ρ is system utilization)

and $\rho = \frac{\lambda}{\mu} = \frac{3}{4}$

$$\Rightarrow \quad L_q = \frac{(3/4)^2}{1-(3/4)} = \frac{9}{16}\times\frac{4}{1} = \frac{9}{4}$$

from equation (1)

$$\frac{9}{4} = \left(\frac{3}{\text{hour}}\right) \times W_q$$

$$\Rightarrow \quad W_q = \frac{3}{4}\text{hours} = 45 \text{ minutes}$$

27. (c)

Demand	Probability	Cumulative probability	
10	0.04	0.04	
15	0.08	0.12	
20	0.13	0.25	→ $p(S-1)$
25	0.26	0.51	→ $p(S)$
30	0.31	0.82	
35	0.09	0.91	
40	0.09	1.00	

Potential profit, $p = S_p - C + C_b$

$S_p \rightarrow$ Selling price/unit

$C \rightarrow$ Purchasing cost/unit

$C_b \rightarrow$ Back ordering or goodwill loss/unit

$$p = 12 - 8 + 1.5$$
$$= ₹5.5$$

Loss per unit, $l = C - C_s + C_h$

C_s = Scrap value/unit

C_h = Holding cost/unit

$$l = 8 - 2 + 0$$
$$l = ₹6$$

$$p(S-1) \le \frac{p}{p+l} \le p(S)$$

Now, $$\frac{p}{p+l} = \frac{5.5}{5.5+6} = 0.4783 = 47.83\%$$

So, for optimum profit number of newspaper purchased is 25.

28. (a)

$$P(W_s \ge T) = e^{-T/W_s}$$

$$0.08 = e^{-12/W_s}$$

$$\ln(0.08) = -\frac{12}{W_s}$$

$$W_s = -\frac{12}{\ln(0.08)} = \frac{-12}{-2.52573} = \frac{-12}{-2.526} = 4.75 \text{ min}$$

We know that, $$W_s = \left(\frac{\rho}{1-\rho}\right) \times \frac{1}{\lambda}$$

$$4.75 = \left(\frac{\rho}{1-\rho}\right) \times \frac{1}{1/6}$$

$$\frac{4.75}{6} = \left(\frac{\rho}{1-\rho}\right)$$

$$\left(\frac{1}{\rho} - 1\right) = \frac{6}{4.75}$$

$$\frac{1}{\rho} = 2.263$$

$$\rho = 0.442$$

$$\frac{\lambda}{\mu} = 0.442$$

$$\mu = \frac{10}{0.442} = 22.62 \text{ customer/hour}$$

29. (c)

In given matrix job 1 cannot be assigned to technician *A*.

M	6	4	3
4	2	7	0
5	3	6	4
7	4	5	4

Step: 1

Subtracting the smallest element in each row from every element of corresponding row.

M	3	1	0
4	2	7	0
2	0	3	1
3	0	1	0

Step: 2

Subtracting the smallest element of every column from corresponding element of each column.

M	3	0	0
2	2	6	0
0	0	2	1
1	0	0	0

Step: 3

Making allocation in opportunity cost matrix:

M	3	[0]	~~0~~
2	2	6	[0]
[0]	~~0~~	2	1
1	[0]	~~0~~	~~0~~

Allocation are, $A \to 3, \quad B \to 4, \quad C \to 1, \quad D \to 2$

Minimum total cost = (4 + 0 + 5 + 4) × 100 = ₹ 1300

30. (a)

Destination / Origin	A	B	C	D	Capacity
P	30 [2]	20 [0]	40 [4]	17 [9]	15/6/4/0
Q	60	28 [0]	35 [19]	52	19/0
R	26 [9]	13 [17]	50	22 [0]	26/09/0
Demand	11/2/0	17/0	23/4/0	09/0	

It is a balanced transportation problem.

Initial solution, Z = 30 × 2 + 40 × 4 + 17 × 9 + 35 × 19 + 26 × 9 + 13 × 17

Initial solution, Z = ₹1493

■■■■