CLASS TEST

SL. : 01 SP_ME_E_30042023

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INDUSTRIAL ENGINEERING

MECHANICAL ENGINEERING

Date of Test : 30/04/2023

ANSWER KEY

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

DETAILED EXPLANATIONS

3. (b)

For long term we use:
Opinion survey
Market trial
Market research
Deplhi technique

4. (d)

$$\text{Total cost} = F + xv$$

F - Fixed cost,
v - Variable cost,
x - is the number of product units

$$F_1 + xv_1 = F_2 + xv_2$$
$$50000 + x \times 9 = 25000 + x \times 19$$
$$x = 2500$$

5. (c)

$$\text{Cycle time} = 6 \text{ (Maximum work station time)}$$

$$\text{Balance delay} = 1 - \left(\frac{\text{Total work}}{n \times \text{cycle time}}\right)$$

$$\text{BD} = 1 - \left(\frac{3+4+6+5+6+6}{6 \times 6}\right) = 1 - \frac{5}{6} = \frac{1}{6} \times 100$$
$$= 16.667\%$$

6. (a)

Step 1: Take minimum process time of M_1 and M_2 and put it on left (if it is of M_1 or if it is of M_2 put it on right (end).
B-A-C-D-E-F
or
B-A-C-E-D-F

7. (b)

$$\text{EOQ} = \sqrt{\frac{2 \times D \times C_o}{C_h}} = \sqrt{\frac{2 \times 80000 \times 4000}{40}} = 4000$$

$$\text{Number of orders} = \frac{D}{EOQ} = \frac{80000}{4000} = 20$$

8. (d)

ABC = It depends on the usage value.
VED = It is on the importance of inventory.
HML = It is based on unit price of inventory.
SDE = It is based on availability of inventory item.

9. (a)

	P	*Q*	*R*	*S*	
I	(20) 5	(20) 3	2	1 (10)	50/40/20/0
II	4	(20) 2	5	9	20/0
III	4	2	(30) 1	4	30/0
	20/0	40/20/0	30/0	10/0	

10. (c)

$$\text{Arrival rate, } \lambda = 10 \text{ min} = 6 \text{ customers/hr}$$

$$\text{Service rate, } \mu = 5 \text{ min} = 12 \text{ customers/hr}$$

Probability that a customer will get a chance to wait in the shop

$$= P_1 + P_2$$

$$= \frac{\lambda}{\mu}\left(1-\frac{\lambda}{\mu}\right)+\left(\frac{\lambda}{\mu}\right)^2\left(1-\frac{\lambda}{\mu}\right)$$

$$= \frac{6}{12}\left(1-\frac{6}{12}\right)+\left(\frac{6}{12}\right)^2\left(1-\frac{6}{12}\right)$$

$$= 0.375$$

11. (b)

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

D	F	(D – F)
70	68	2
68	69	–1
82	68.5	13.5
95	75.25	19.75

Mean absolute percentage error,

$$\text{MAPE} = \frac{\sum_{i=1}^{n}\left|\frac{D_i - F_i}{D_i}\times 100\right|}{n} = \frac{\left(\frac{2}{70}+\frac{1}{68}+\frac{13.5}{82}+\frac{19.75}{95}\right)}{4}\times 100$$

$$\text{MAPE} = 10.395 \approx 10.4\%$$

12. (c)

$$\text{Desired cycle time, } T_c = \frac{\text{Production time available}}{\text{Desired units of output}}$$

$$= \frac{8\times 60}{100} = 4.8 \text{ min}$$

Theoretical minimum number of work stations,

$$\Rightarrow \quad \frac{\Sigma t_i}{t_c} = \frac{2+1+2+3+1+3}{4.8}$$

$$= 2.5 \simeq 3 \text{ work stations}$$

Note : Number of stations will always be an integer.

13. (c)

$$\text{Critical ratio} = \frac{\text{Due date}}{\text{Processing time}}$$

Jobs	C.R.
I	$\frac{32}{8} = 4$
II	$\frac{41}{6} = 6.83$
III	$\frac{28}{9} = 3.11$
IV	$\frac{35}{11} = 3.18$
V	$\frac{46}{10} = 4.6$

Arrange all jobs in increasing order of CR.

Jobs	Processing time	Due date	In	Out
III	9	28	0	9
IV	11	35	9	20
I	8	32	20	28
V	10	46	28	38
II	6	41	38	44

$$\text{Average job flow time} = \frac{9+20+28+38+44}{5} = 27.8$$

14. (b)

$$\text{Length of queue} = \frac{\rho^2}{1-\rho}$$

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

$$\lambda = 5$$

$$\mu = \frac{60}{10} = 6$$

$$\rho = \frac{5}{6}$$

$$L_q = \frac{(5/6)^2}{1-\frac{5}{6}} = \frac{25}{6}$$

$$\text{Waiting time} = \frac{L_q}{\lambda} = \frac{25}{5\times 6} = \frac{5}{6}\times 60 = 50 \text{ min}$$

15. **(b)**

We know, $$Q^* = \sqrt{\frac{2DC_o}{C_h}\left(\frac{C_b + C_h}{C_b}\right)}$$

$C_b = 0.25 \times 20$ = Rs. 5/unit/year
$C_h = 0.2 \times 20$ = Rs. 4/unit/year

$$Q^* = \sqrt{\frac{2 \times 10000 \times 10}{4}\left(\frac{5+4}{5}\right)} = 300 \text{ units}$$

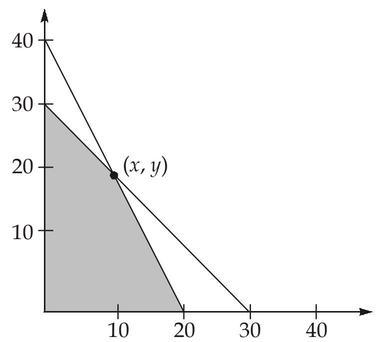
But we know for optimum backorder (S^*) :

$$(Q^* - S^*)C_h = S^* C_b$$
$$(300 - S^*)4 = S^* \times 5$$
$$S^* = \frac{400}{3}$$

16. **(b)**

Let x and y be the units of model P and Q

$$\text{Maximum, } p = 75x + 60y$$
$$8x + 4y \leq 160 \quad \text{... (i)}$$
$$x + y \leq 30 \quad \text{... (ii)}$$



$x \geq 0, y \geq 0$

Solving by graphical method

Point (x, y) is intersection of (i) and (ii)

$$8x + 4y = 160$$
$$x + y = 30$$

Solving we get, $x = 10$
$y = 20$

So, corner points are:
(0, 30), (20, 0), (10, 20)

Profit for (20, 0)
$$p = 75 \times 20 + 60 \times 0 = \text{Rs.}1500$$
For (0, 30)
$$p = 75 \times 0 + 60 \times 30 = \text{Rs.}1800$$
For (10, 20)
$$p = 75 \times 10 + 20 \times 60 = \text{Rs.}1950$$

Hence, for maximum profit, $P = 10$, $Q = 20$

17. **(b)**

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

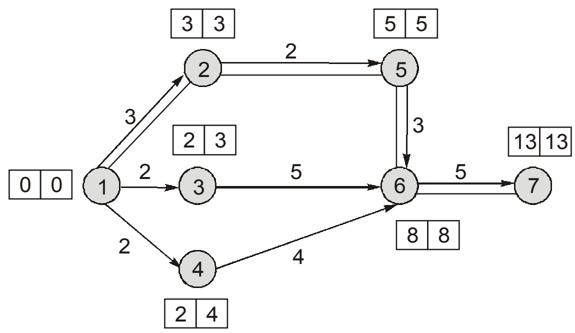
	M_1	M_2	M_3	M_4
J_1	2	0	1	4
J_2	0	1	4	2
J_3	3	2	0	1
J_4	1	3	0	2

Then apply column transaction (Subtract column minimum by others)

	M_1	M_2	M_3	M_4
J_1	2	$\boxed{0}$	1	3
J_2	$\boxed{0}$	1	4	1
J_3	3	2	$\cancel{0}$	$\boxed{0}$
J_4	1	3	$\boxed{0}$	1

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

18. (c)



Critical path is 1 – 2 – 5 – 6 – 7.

19. (d)

First we calculate EOQ for $C = 14$,

$$\text{EOQ} = \sqrt{\frac{2DC_o}{C_h}} = \sqrt{\frac{2 \times 3000 \times 150}{0.25 \times 14}} = 507.092 \text{ units}$$

But this EOQ is less than 600, hence our assumption is wrong.

Then we calculate EOQ for $C = 15$

$$\text{EOQ} = \sqrt{\frac{2 \times 3000 \times 150}{0.25 \times 15}} = 489.97 \text{ units}$$

This is less than 600, so we check total cost for EOQ at $C = 15$ and for $Q = 600$ of $C = 14$

At EOQ,

$$TC = D \times C + \frac{D}{EOQ} \times C_o + \frac{EOQ}{2} \times C_h$$

$$TC = \text{Rs. } 46837.117$$

At $Q = 600$, $C = 14$,

$$TC = 3000 \times 14 + \frac{3000}{600} \times 150 + \frac{600}{2} \times 14 \times 0.25$$

$$TC = \text{Rs. } 43800$$

Hence, minimum cost is for $Q = 600$ units.

20. (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 unit of P, units of S required = 4

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

21. (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
$n = 7$	$\Sigma y = 492$	$\Sigma x = 0$	$\Sigma x^2 = 28$	$\Sigma xy = -135$

$$\Sigma y = \Sigma a + b\Sigma x$$
$$\Rightarrow \quad \Sigma y = na + b\Sigma x$$
$$\Rightarrow \quad 492 = 7 \times a + 0$$
$$\Rightarrow \quad a = 70.2857$$
$$\Sigma xy = a\Sigma x + b\Sigma x^2$$
$$\Rightarrow \quad -135 = 0 + b \times 28$$
$$\Rightarrow \quad b = -4.82143$$

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

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

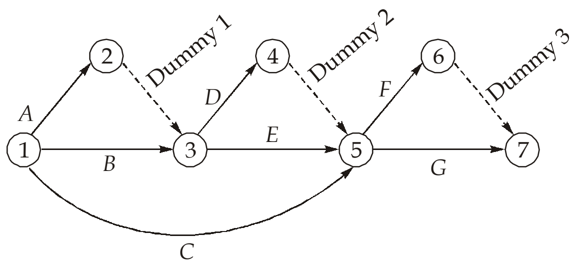
22. (c)

The three determinants of the type of layout are type of product, type of process and the volume of production.

Assembly shops of automobiles is an example of mass production.

23. (b)

Network diagram:



25. (b)

$$C_0 = 60 \text{ per order}$$

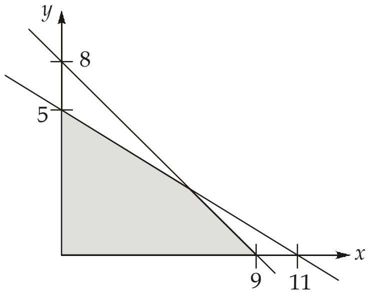
For order size greater than 100

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

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

26. (c)

Number of independent feasible solutions will be infinite. Because all the points within the feasible region will be a solution.



27. (d)

$$\text{Total cost} = 4x^2 - 19x + 25000 + 3x^2 - 37x + 26000$$

$$\frac{dT}{dx} = 8x - 19 + 6x - 37$$

For minimum cost $\frac{dT}{dx} = 0$

$$0 = 14x - 56$$

$$x = \frac{56}{14} = 4$$

28. (d)

$$\lambda = \frac{120}{24 \times 60} = \frac{1}{12} \text{ per min,}$$

$$\mu = \frac{1}{10} \text{ per min}$$

$$\rho = \frac{\lambda}{\mu} = \frac{1/12}{1/10} = \frac{10}{12} = \frac{5}{6}$$

$$L_q = \frac{\rho^2}{1-\rho} = \frac{\left(\frac{5}{6}\right)^2}{\left(1 - \frac{5}{6}\right)} = \frac{25 \times 6}{36 \times 1} = 4\frac{1}{6} \text{ patient}$$

$$L_q = \frac{\rho^2}{1-\rho}$$

Given, $\left(L_q = \frac{3}{2}\right)$, $\lambda = \frac{1}{12}$, $\mu = ?$

$$\frac{3}{2} = \frac{\lambda^2}{\mu(\mu-\lambda)} \Rightarrow \quad \frac{3}{2} = \frac{\left(\frac{1}{12}\right)^2}{\mu\left(\mu-\frac{1}{12}\right)}$$

$$\Rightarrow \qquad \mu\left(\mu-\frac{1}{12}\right) = \frac{1\times 2}{144\times 3}$$

$$\Rightarrow \qquad \mu^2-\frac{\mu}{12} = \frac{1}{216}$$

$$\Rightarrow \qquad 12\mu^2 - \mu - 0.0555 = 0$$

On solving, μ = 0.1214 per min.

Average time required for treatment = 8.237 min

Budget per person = 100 + (10 – 8.237) × 10

Budget per person = ₹117.63

29. (a)

The 3 period moving average forecast (F_{61})

$$F_{61} = \frac{D_3+D_4+D_5}{3} = \frac{10+12+13}{3} = 11.67$$

The 5 period moving average forecast (F_{62})

$$F_{62} = \frac{D_1+D_2+D_3+D_4+D_5}{5} = 11$$

$$F_{61} - F_{62} = 11.67 - 11 = 0.67$$

30. (a)

$$T_{\text{expected}} = \frac{t_o+4t_m+t_p}{6}$$

$$= \frac{9+(4\times 15)+21}{6} = 15 \text{ days}$$

$$\text{Standard deviation (S.D.)} = \frac{b-a}{6} = \frac{21-9}{6} = 2$$

$$Z = \frac{x-\bar{x}}{\sigma} = \frac{15-15}{2} = 0$$

$$p(o) = 0.5 \simeq 50\%$$

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