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Industrial Engineering

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CLASS TEST 2019-2020

MECHANICAL ENGINEERING

Date of Test : 01/09/2019

ANSWER KEY > Industrial Engineering

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

Detailed Explanations

1. (d)

ABC analysis → usage values
HML analysis → Cost per item
VED analysis → Criticality
XYZ analysis → based on closing inventory values

2. (c)

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})

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

$$F_{61} - F_{62} = 11.67 - 11 = 0.67 \text{ units}$$

4. (a)

$$8 = 5 \times 0.5 + 0.2 \times (10 + 5 + 7 + x)$$

$$\Rightarrow \quad x = 5.5$$

5. (d)

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

$$\text{In case of expert A, the variance } \left(\frac{8-4}{6}\right)^2 = \frac{4}{9} = 0.444$$

$$\text{In case of expert B, the variance } \left(\frac{10-4}{6}\right)^2 = 1$$

$$\text{In case of expert C, the variance } \left(\frac{8-3}{6}\right)^2 = 0.6944$$

$$\text{In case of expert D, the variance } \left(\frac{9-6}{6}\right)^2 = 0.25$$

So, the variance is less in the case of D. Hence, it is concluded that the expert D is more certain about his estimates of time.

10. (a)

$$D = 1000 \text{ units}$$
$$C_0 = \text{Rs. } 40/\text{order}$$
$$C_h = 10\% \text{ of } 500 = \text{Rs. } 50/\text{unit/year}$$

$$\text{ordering quantity per month} = \frac{1000}{12} = 83.33$$

$$(\text{TIC})_{83.33} = \frac{1000}{83.33} \times 40 + \frac{83.33}{2} \times 50 = 480 + 2083.25 = 2563.25$$

$$\text{Total cost} = 1000 \times 500 + 2563.25 = ₹502563.25$$

11. (c)

Year	Demand (D_i)	Forecast (F_i)	Error ($D_i - F_i$)	$\lvert$Error$\rvert$
1	125	126	– 1	1
2	130	132	– 2	2
3	145	138	7	7
4	150	144	6	6
5	175	150	25	25
				$\Sigma\lvert D_i - F_i\rvert = 41$

$$\text{Mean absolute error} = \frac{41}{5} = 8.2$$

12. (d)

$$\text{Standard deviation } \sigma = \sqrt{16} = 4 \text{ for 95\% probability } Z = 1.65$$

Now $$\frac{T_S - T_E}{\sigma} = Z$$

Therefore $$T_S = \sigma Z + T_E = 4 \times 1.65 + 50 = 57 \text{ weeks}$$

13. (b)

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

$$F_{July} = 380 + 0.75 \times \{420 - 380\} = 410$$

$$F_{August} = 410 + 0.75 \times \{440 - 410\} = 432.5 \simeq 433$$

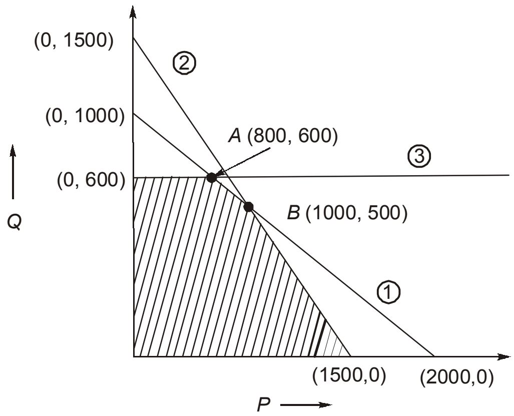
Month	D	F
June	420	380
July	440	410
August		

14. (a)

Given
$$P + 2Q \leq 2000 \quad \text{...(i)}$$
$$P + Q \leq 1500 \quad \text{... (ii)}$$
$$Q \leq 600$$

Objective function

$$Z_{max} = 3P + 5Q$$

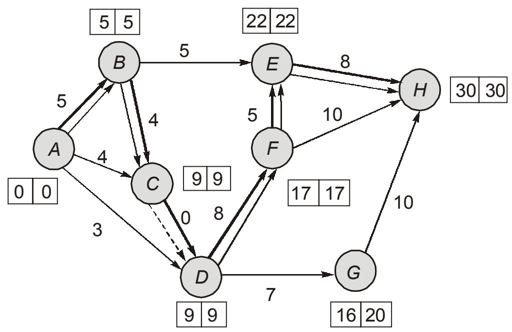


At point A $\quad z = 3 \times 800 + 600 \times 5 = 5400$

At point B $\quad z = 3 \times 1000 + 5 \times 500 = 5500$

Hence z to be maximum at (1000, 500)

15. (c)



∴ project duration is 30 days

16. (b)

	S_1	S_2	S_3
P	60	95	105
Q	85	70	110
R	90	100	80

Step 1 : Subtract minimum entry in each row from all the entries on that row,

	S_1	S_2	S_3
P	0	35	45
Q	15	0	40
R	10	20	0

Step 2 : Making the assignment

[0]	35	45
15	[0]	40
10	20	[0]

The minimum cost = 60 + 70 + 80 = ₹ 210

17. (a)

$$\text{Cycle time} = T = 1.5 \text{ month} = 0.125 \text{ year}$$

$$N = \frac{1}{T} = 8\,;\; Q = 2250$$

$$\text{Annual demand} = D = N \times Q = 18{,}000 \text{ units}$$

$$\text{Tic}(Q) = \text{O.C} + \text{H.C} = NC_O + \frac{Q}{2}C_h = ₹\ 26025$$

$$\text{Tic}(Q) = \sqrt{2DC_oC_h\left(\frac{C_b}{C_h + C_b}\right)} = ₹\ 5452.04$$

$$\Rightarrow \quad \%\text{saving} \; \frac{TIC(Q) - TIC(Q^*)}{TIC(Q^*)} = 10.51\%$$

18. (d)

$$\text{TF} = \text{LFT} - \text{EFT} = 58 - 40 = 18$$

$$\text{FF} = (\text{EFT} - \text{EST}) - t_{ij} = (40 - 21) - 19 = 0$$

$$\text{IF} = (E_j - L_i) - t_{ij} = (40 - 39) - 19 = -18$$

Now,

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

19. (a)

$$x_{\text{break even}} = \frac{F}{s-v} = \frac{5000}{5} = 1000$$

$$CM = (s-v)x = 6000$$

$$\Rightarrow \quad x = \frac{6000}{5} = 1200$$

$$\Delta x = 200 \text{ units}$$

20. (b)

2	10	9	7
15	4	14	8
13	14	16	11
4	15	13	9

0	8	7	5
11	0	10	4
2	3	5	0
0	11	9	5

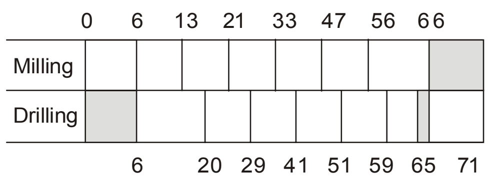
0	8	2	5
11	0	5	4
2	3	0	0
0	11	4	5

	S_1	S_2	S_3	S_4
A	~~0~~	6	[0]	3
B	13	[0]	5	4
C	4	3	~~0~~	[0]
D	[0]	9	2	3

21. (a)

According to Johnson rule, the correct order will be

E - F - B - A - D - C - G



$$\text{Utilisation of milling M/C} = \frac{66}{71} \times 100 = 92.95\%$$

$$\text{Utilisation of drilling M/C} = \frac{64}{71} \times 100 = 90.14\%$$

23. (d)

Let Q be the number of units stocked per week and let r be the demand for it, i.e., the actual number of units sold per week.

Given, C_1 = ₹ 30 per unit per week

and C_2 = ₹ 70 per unit per week

∴ The critical ratio is

$$p_c = \frac{C_2}{C_1 + C_2} = \frac{70}{30+70} = 0.70$$

The cumulative distribution of weekly demand as follows:

Monthly sales (r)	0	1	2	3	4	5	6
p(r)	0.01	0.06	0.25	0.35	0.20	0.03	0.1
$\sum_{r=0}^{Q} p(r)$	0.01	0.07	0.32	0.67	0.87	0.90	1.00

Since the critical ratio is 0.7, i.e. lies between 0.67 and 0.87.
Hence, 4 units must be stocked every week.

24. (c)

$$\mu = 5 \text{ customer/hour}$$

As the shopkeeper is idle during 30% of time

$$1 - \rho = 0.3$$

$$\rho = 0.7 = \frac{\lambda}{\mu}$$

⇒ $\lambda = 3.5$ customer/hour

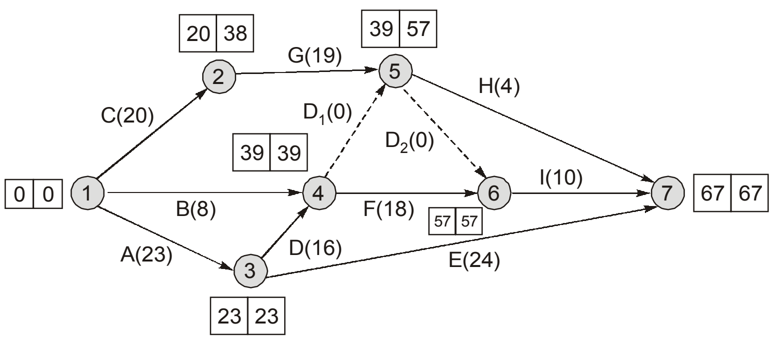
Average number of customer in the system (L_s)

$$= \frac{\rho}{1-\rho} = \frac{0.7}{1-0.7} = \frac{7}{3}$$

Average waiting time of customer in the system

$$= \frac{L_s}{\lambda} = \frac{7}{3 \times 3.5} = \frac{2}{3} \times 60 = 40 \text{ minutes}$$

25. (a)



Independent float (5 – 7) = 67 – 57 – 4 = 6

26. (c)

'∈' should be allocated to minimum cost cell, but it should 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.

27. (d)

Here, we are given:

$$\lambda = \frac{1}{10} \times 60 \text{ or } 6 \text{ per hour}$$

and $$\mu = \frac{1}{3} \times 60 \text{ or } 20 \text{ per hour}$$

The installation of a second both will be justified, if the arrival rate is greater than the waiting. Now, if λ' denotes the increased arrival rate, expected waiting time is:

$$E(\omega) = \frac{\lambda'}{\mu(\mu - \lambda')}$$

$$\Rightarrow \quad \frac{3}{60} = \frac{\lambda'}{20(20 - \lambda')}$$

or $$\lambda' = 10$$

Hence, the arrival rate should become 10 customer per hour to justify the second booth.

28. (c)

$$D = 10{,}000 \text{ units}, C_0 = ₹\ 10 \text{ per order}$$

$$C_h = 20\% \text{ of } ₹\ 20 = ₹\ 4 \text{ per unit per year}$$

$$C_b = 25\% \text{ of } ₹\ 20 = ₹\ 5 \text{ per unit per year}$$

When back ordering is permitted

$$Q = \sqrt{\frac{2DC_0}{C_h} \times \frac{C_h + C_b}{C_b}} = \sqrt{\frac{2 \times 10{,}000 \times 10}{4} \times \frac{4+5}{5}} = 300 \text{ units}$$

Optimum quantity of the product to be back ordered is given by

$$S = Q \times \left(\frac{C_h}{C_h + C_b}\right) = 300 \times \frac{4}{4+5} = 133 \text{units}$$

Maximum inventory level $= Q - S = 300 - 133 = 167$ units

29. (b)

Maximum station time $(T_{s_i})_{max} = 10$ minutes

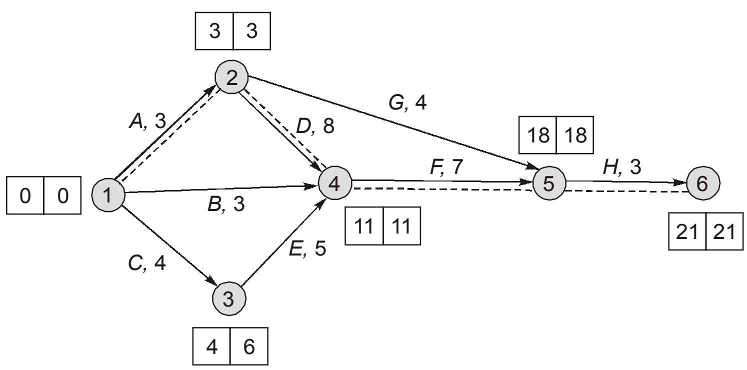
Smoothness index (S.E.)

$$= \sqrt{\sum_{i=1}^{n}\left[\left(T_{s_i}\right)_{max} - T_{s_i}\right]^2} = \sqrt{(10-7)^2 + (10-9)^2 + (10-7)^2 + (10-10)^2 + (10-9)^2 + (10-6)^2}$$

(S.E.) = 6

30. (c)

The network of the project is



Critical path $A \rightarrow D \rightarrow F \rightarrow H$

Critical time = 21 units

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