Industrial Engineering Test 2

Number of Questions 35 **Time:60 min.**

Directions for questions 1 to 35: Select the correct alternative from the given choices.

1. In forecasting by exponential smoothing method, higher values of smoothing constant.
(A) will be more sensitive to forecast of recent past.
(B) will be more sensitive to demand of recent past
(C) will not be affected by forecast of previous years.
(D) will not be affected by demand of previous years

2. The actual observed time for an operations was 1.5 minutes per piece. Performance rating of the operator was 120. If 5 percent personal time is to be provided, standard time in minutes per piece is
(A) 1.46 (B) 1.58
(C) 1.62 (D) 1.89

3. Queuing model is based on the assumption that arrival rate and service time are respectively
(A) Exponentially and Poisson distributed
(B) Poisson and Exponentially distributed
(C) Poisson and Logarithmically distributed
(D) Exponentially and Logarithmically distributed

4. In a transportation problem, North−West corner rule is used to obtain
(A) an optimum solution
(B) a minimum cost solution
(C) an initial feasible solution
(D) a near optimum solution

5. Jobs arrive in a machine shop following a Poisson distribution with a mean rate of 1/hr. If average time to complete the job is 30 minutes, probability that there are no jobs waiting or in service is
(A) 0.6 (B) 0.5
(C) 0.4 (D) 0.3

6. In a PERT network expected time to finish an activity is 22 days. Variance of the activity is 9 days. If pessimistic time of the activity is 26 days, optimistic time of the activity is
(A) 8 days (B) 10 days
(C) 12 days (D) 14 days

7. ABC analysis is a method used in
(A) Flow of material
(B) Inventory control
(C) Materials Requirement Planning
(D) Job evaluation

8. Annual requirement of an item procured on economic order quantity basis is 6000 units. If average inventory is 300 units, unit cost is ₹100 and ordering cost is ₹300, the number of orders placed in an year is
(A) 6 (B) 8
(C) 9 (D) 10

9. Float of activities in the critical path of a PERT/CPM network
(A) increases continuously
(B) decreases continuously
(C) is zero
(D) may increase or decrease

10. Demand and forecast of a product for January was 15000 and 12250 numbers respectively. Using single exponential smoothening method, forecast for the month of February was calculated as 12938 number's. The smoothening coefficient used is
(A) 0.25 (B) 0.35
(C) 0.55 (D) 0.75

11. Economic ordering quantities of two items are in the ratio 1 : 2. Holding cost per unit per annum is same for both items. Ordering cost for item 1 is ₹100 and for item 2 is ₹400. If annual requirement of item 1 is 1000, annual requirement of item 2 is
(A) 750 (B) 1500
(C) 1000 (D) 2000

12. For the production of an item, fixed cost was ₹24000 and break even quantity was 3000 units. Profit corresponding to a sales volume of 4000 units is
(A) ₹7000 (B) ₹8000
(C) ₹9000 (D) ₹10000

13. In PERT, expected duration of an activity is given by

(A) $t_e = \dfrac{t_o + 4t_m + t_p}{4}$

(B) $t_e = \dfrac{t_o + 4t_m + t_p}{6}$

(C) $t_e = \dfrac{t_o + 3t_m + t_p}{5}$

(D) $t_e = \dfrac{2t_o + 3t_m + t_p}{6}$

14. In a service station vehicles arrive at the rate of 4 numbers per hour. If service time per vehicle is 10 minutes, the traffic intensity is
(A) 1.5 (B) 1.2
(C) 0.95 (D) 0.67

15. Average inventory of a firm with a given annual demand
(A) increases with the number if orders placed in a year
(B) decreases with the number of orders placed in a year
(C) is independent of the number of orders
(D) decreases if buffer stock is increased

16. Sales of a component during the last four consecutive months were 74, 72, 86 and 99. Using an exponentially smoothing factor 0.4, the expected sales during current month is.

(A) 68 (B) 70
(C) 76 (D) 80

17. Demand for a product from April to October was as follows

Month	Demand
April	116
May	122
June	115
July	121
August	119
September	120
October	123

Forecast for November based on 5 months moving average is

(A) 120 (B) 122
(C) 121 (D) 123

18. The arrival sequence of six jobs with processing times are as follows

Jobs	Processing times (days)
P	5
Q	10
R	6
S	11
T	7
U	9

If the jobs are scheduled on the basis of Last come first serve basis, average flow time in days is

(A) 27.86 (B) 28.24
(C) 29.33 (D) 30.18

19. The number of jobs arriving at a work centre with their processing time and due date is given below,

Job	Processing Time(days)	Due date (days)
P	8	15
Q	6	19
R	4	24
S	10	14
T	5	39

Total lateness in the system is

(A) 5.2 days (B) 5.4 days
(C) 6.5 days (D) 6.8 days

20. Supply of a component has the following price schedule
Up to 99 Nos – ₹1000/unit.
1000 nos and above – ₹950/unit.
Inventory holding cost is 25% of the value of inventory. Ordering cost is ₹2000 per order. If annual requirement is 300 Nos, the optimal order quantity is

(A) 85 (B) 90
(C) 95 (D) 100

21. Annual usage of an item is 20000 units. The item is procured in lots of economic order quantity of 1155 Nos with a lead time of 15 days. No of working days per year is 275. Maximum usage rate during the last three years was 90 units per day. Safety stock and reorder point for the item is respectively.

(A) 259, 1350 (B) 252, 1341
(C) 363, 1392 (D) 392, 1398

22. For a product, fixed cost is ₹60000 and variable cost per unit is ₹20. If sales price is ₹30 per unit the break even production quantity is

(A) 5000 (B) 5500
(C) 6000 (D) 6500

23. Fixed cost of a product is ₹5000. Total variable cost corresponding to the present volume of sales of ₹25000 is ₹15000. Sales volume in rupees corresponding to the break even point is

(A) ₹12250 (B) ₹12500
(C) ₹12750 (D) ₹12800

24. Consider the following linear programming problem.
Maximize
$Z = 2x + 3y$
Subject to constraints
$x \geq 4$
$y \geq 6$
$3x + 2y \geq 18$
$x \geq 0, y \geq 0$
The optimum solution is

(A) 16 (B) 18
(C) 20 (D) 22

25. Consider the linear programming problem given below
Maximize
$Z = 3x + 4y$
Subject to the constraints
$x \geq 4$
$y \geq 5$
$3x + 4y \geq 24$

(A) The LPP has a single optimal solution
(B) The LPP has multiple optimal solution more than 2
(C) The LPP is not feasible
(D) The LPP has 2 optimal solutions

26. Figure shows a transportation problem showing unit cost of transporting from 3 sources to 4 destinations

	D_1	D_2	D_3	D_4	
S_1	17	16	19	13	250
S_2	19	16	17	15	250
S_3	17	15	16	17	200
Demand	150	250	100	100	

Using Vogel's approximation method the first allocation is in the route

(A) $S_1 D_2$ (B) $S_2 D_3$
(C) $S_1 D_4$ (D) $S_2 D_1$

27. Demand for a product during April, May and June was 1500, 1250 and 1300 respectively. Forecast for June was 1200. Using single exponential smoothening method (smoothening coefficient = 0.3), forecast for July is

(A) 1230 (B) 1256
(C) 1285 (D) 1298

28. 5 jobs are to be machined in two machines in a work shop. Each job requires initial preparation in machine M_1 and finishing machining in machine M_2. The times required are as follows.

Job	Preparations	Finishing(hr)
P	2	4
Q	5	3
R	6	5
S	3	6
T	4	7

The sequencing of the jobs for minimum total completion time is

(A) *P S Q R T* (B) *S T P Q R*
(C) *P S T R Q* (D) *S T Q R P*

29. 4 jobs are to be done on 4 different machines. Time required for the jobs on each machine in hours is as given below. Cost of production is ₹100 per hour for each job. Minimum total cost for doing all the jobs is

Jobs	Machine			
	M_1	M_2	M_3	M_4
P	10	6	8	10
Q	12	7	7	8
R	9	10	5	9
S	11	8	6	12

(A) ₹2600 (B) ₹2900
(C) ₹3200 (D) ₹3500

30. In a production centre requirement of a component depending up on the production schedule is as follows

Weeks							
1	2	3	4	5	6	7	8
25	0	15	10	0	0	35	10

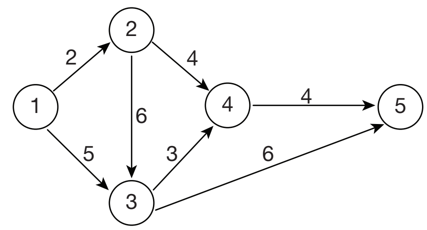
Quantity on hand at the beginning is 30 Nos. There is a scheduled receipt of 50 Nos in the second week. If lead time for procurement is 4 weeks and order quantity is 50 Nos, the time for order release is

(A) 2^{nd} week (B) 3^{rd} week
(C) 4^{th} week (D) 5^{th} week

31. Average time between two arrivals at the counter of a readymade garment shop is 5 minutes. The average time of the counter clerk to serve the customer is 3 minutes. If the arrivals are Poisson distributed and service time has negative exponential distribution, probability that the counter clerk is idle is

(A) 0.3 (B) 0.4
(C) 0.5 (D) 0.6

Common data for questions 32 and 33:



Optimistic time, most likely time and pessimistic time of the activities of the net work shown are as follows

Activity	Optimistic time t_o (days)	Most likely time t_m(days)	Pessimistic time t_p (days)
1 – 2	1	2	3
1 – 3	3	5	7
2 – 3	5	6	7
2 – 4	2	4	6
3 – 4	2	3	4
3 – 5	4	6	8
4 – 5	2	4	6

32. Critical path duration in days is

(A) 8 (B) 10
(C) 12 (D) 15

33. Standard deviation of the critical path is

(A) 0.8815 (B) 0.9724
(C) 1.2365 (D) 1.6667

Statement for linked answer questions 34 and 35:

Trucks arrive at the truck dock of a whole sale grocer at the rate of 8 per hour, and the distribution of arrivals is Poisson. The loading and/ or unloading time averages 5 minutes and have a negative exponential distribution.

34. Average number of trucks waiting is

(A) 2.02 (B) 1.94
(C) 1.62 (D) 1.33

35. Average waiting time for a truck is

(A) 10 min (B) 12 min
(C) 14 min (D) 16 min

Answer Keys

1. B	**2.** D	**3.** B	**4.** C	**5.** B	**6.** A	**7.** B	**8.** D	**9.** C	**10.** A
11. C	**12.** B	**13.** B	**14.** D	**15.** B	**16.** D	**17.** A	**18.** C	**19.** B	**20.** D
21. A	**22.** C	**23.** B	**24.** D	**25.** C	**26.** C	**27.** A	**28.** C	**29.** B	**30.** B
31. B	**32.** D	**33.** A	**34.** D	**35.** A					

Hints and Explanations

1. Choice (B)

2. Standard time = Normal time (1 + % allowance)
Where normal time
= observed time × performance rating

$\therefore$ Standard time $= 1.5 \times \frac{120}{100} \times (1 + 0.05)$

= 1.89 minutes. Choice (D)

3. Choice (B)

4. Choice (C)

5. Arrival rate λ = 1/hr

service rate $\mu = \frac{60}{30}$ = 2/hr

Probability that there are no jobs in the system

$= 1 - \frac{\lambda}{\mu} = 1 - \frac{1}{2} = 0.5.$ Choice (B)

6. t_e = 21.5 days
t_p = 26 days
variance σ^2 = 9 days
standard deviation $\sigma = \sqrt{9}$ = 3 days

But $\sigma = \frac{t_p - t_o}{6}$

$\therefore$ optimistic time
t_o = 26 – 18 = 8 days. Choice (A)

7. Choice (B)

8. Order quantity = average inventory × 2
= 300 × 2

Number of orders $= \frac{\text{Annual requirement}}{\text{Order quantity}}$

$= \frac{6000}{600} = 10$. Choice (D)

9. Choice (C)

10. D_t = 15000
F_t = 12250
$F_{t+1} = \alpha D_t + (1 - \alpha) F_t$
$= F_t + \alpha (D_t - F_t)$
12938 = 12250 + α (15000 – 12250)
2750 α = 688
α = 0.25. Choice (A)

11. $\frac{(EOQ)_1}{(EOQ)_2} = \sqrt{\frac{2A_1C_{o1}/C_h}{2A_2C_{o2}/C_h}} = \sqrt{\frac{A_1C_{o1}}{A_2C_{o2}}}$

$\therefore \frac{1}{2} = \sqrt{\frac{1000 \times 100}{A_2 \times 400}}$

$\frac{1}{4} = \frac{1000}{4A_2}$

A_2 = 1000 Nos. Choice (C)

12. $F = (s - v) \times$ Break even quantity
where F = fixed cost
s = sales price/ unit
v = variable cost/unit
$\therefore$ 24000 = $(s - v) \times 3000$

$(s - v) = \frac{24000}{3000}$

= ₹8/unit
$F + P = (s - v) \times$ sales volume
Where P = profit
$\therefore$ 24000 + P = 8 × 4000
P = ₹8000. Choice (B)

13. Choice (B)

14. Arrival rate λ = 4/hr

service rate $\mu = \frac{60}{10}$
= 6/hr

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

$= \frac{4}{6} = 0.67.$ Choice (D)

15. Choice (B)

16. $F_t = \alpha D_{t-1} + \alpha (1 - \alpha) D_{t-2} + \alpha (1 - \alpha)^2$
$D_{t-3} + \alpha (1 - \alpha)^3 D_{t-4} + \ldots\ldots\ldots.$
F_t = 0.4 × 99 + 0.4 × 0.6 × 86 + 0.4 ×
$0.6^2 \times 72 + 0.4 \times 0.6^3 \times 74 + \ldots\ldots\ldots$
= 77 + …………
Say 80. Choice (D)

17. 5 months moving average

$= \frac{123 + 122 + 119 + 121 + 115}{5} = 120$

$\therefore$ Forcast for November
= 120. Choice (A)

18.

Job sequences	Processing time	Flow time
U	9	0 + 9 = 9
T	7	9 + 7 = 16
S	11	16 + 11 = 27
R	6	27 + 6 = 33
Q	10	33 + 10 = 43
P	5	43 + 5 = 48

Total flow time = 9 + 16 + 27 + 33 + 43 + 48
= 176 days

Average flow time = $\frac{176}{6}$

= 29.33 days. Choice (C)

19. Arranging as per shortest processing time,

Job	Processing Time	Flow Time	Due date	Lateness
R	4	4	24	–
T	5	9	39	–
Q	6	15	19	–
P	8	23	15	8
S	10	33	14	19

Total lateness = 8 + 19 = 27 days

Average lateness = $\frac{27}{5}$ = 5.4 days. Choice (B)

20. *EOQ* for the second price

$$Q_2 = \sqrt{\frac{2AC_o}{C_u \times i}}$$

$$= \sqrt{\frac{2\times 300\times 2000}{950\times 0.25}} = 71$$

This is less than the price break up point. So not valid.
Total cost (optimal for first price)

$$= \sqrt{2C_oC_h \times A} + A \times C_u$$

$$= \sqrt{2\times 2000\times (1000\times 0.25)\times 300} + 300 \times 1000$$

= ₹317320

Total cost for the price break up point (corresponding to second price) ie 100

$$= \frac{A}{Q}\times C_o + \frac{Q}{2}\times C_h + A\times C_u$$

$$= \frac{300}{100}\times 2000 + \frac{100}{2}\times 950\times 0.25 + 300 \times 950$$

= ₹302875

This is less than total cost corresponding to Q_1 optimal

∴ Optimal order quantity is 100. Choice (D)

21. Annual usage A = 20000

Economic order quantity Q = 1155 no.s

Average usage rate = $\frac{20000}{275}$ = 72.73 / day

Maximum usage rate = 90/day

Lead time = 15 days

Buffer stock = (max. usage – average usage) × lead time
= (90 – 72.73) × 15 = 259 Nos

cycle time = $\frac{Q}{A}\times 275$

$= \frac{1155}{20000}\times 275 = 15.88$ days

Reorder point = Buffer stock + $Q \times \frac{\text{lead time}}{\text{cycle time}}$

= 259 + 1155 × 15.88
= 1350 units. Choice (A)

22. F = ₹60000
v = ₹20 per unit
s = ₹30 per unit
$F = (s - v)\, x$
Where x = break even quantity
∴ 60000 = (30 – 20)x
x = 6000 unit. Choice (C)

23. Fixed cost F = ₹5000
Variable cost V = ₹15000
Sales volume S = ₹25000
Contribution / sales ratio

(c/s ratio) = $\frac{S-V}{S}$

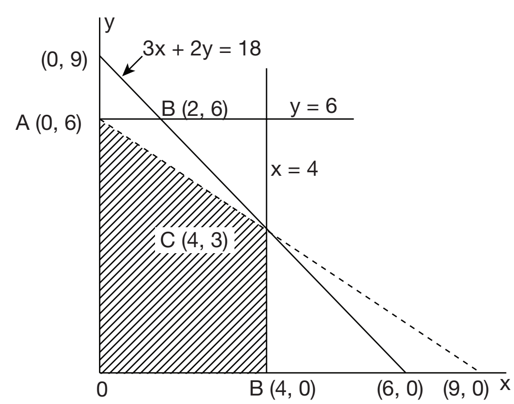
$= \frac{25000-15000}{25000} = 0.4$

Break even sales = $\frac{F}{c/s\ \text{ratio}}$

$= \frac{5000}{0.4}$

= ₹12500. Choice (B)

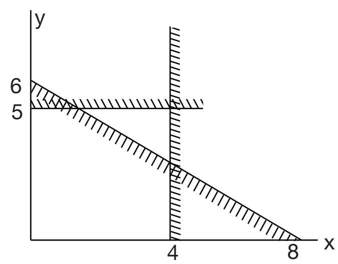
24.



Objective function is ploted for an arbitrary value of Z = 18
i.e., for $2x + 3y = 18$
Value of Z at point $B(2, 6)$
$Z = 2 \times 2 + 3 \times 6 = 22$

Value Z at point c(4, 3)
$Z = 2 \times 4 + 3 \times 3 = 17$
Other feasible corners A and D have lesser values
$\therefore$ The optimum solution is $Z = 22$. Choice (D)

25.



There is no common area satisfying all the three constraints
So the LPP is infeasible.
Choice (C)

26.

	D_1	D_2	D_3	D_4	Penalty Cost
S_1	17	16	19	13	16 – 13 = 3
S_2	19	16	17	15	16 – 15 = 1
S_3	17	15	16	17	16 – 15 = 1
Penalty Cost	19 – 17 =2	16 – 15 = 1	17 – 16 = 1	15 – 13 = 2	

Highest penalty cost is in the first row corresponding to S_1. Least cost in this row is 13 which comes under column D_4. So first allotment is in route S_1 D_4. Choice (C)

27. Forecast for July
$F_{t+1} = \alpha D_t + (1 - \alpha) F_t$
$= 0.3 \times 1300 + (1 - 0.3) \times 1200 = 1230$. Choice (A)

28. Applying Johnson's rule for optimal sequencing, job of shortest time is allocated first starting from left fro M_1 and from right for M_2.

P	S	T	R	Q

So the sequence for minimum completion time is $P\,S\,T\,R\,Q$. Choice (C)

29. Subtracting least value of each row and column from other values of the corresponding rows and columns

	M_1	M_2	M_3	M_4
P	4	0	2	4
Q	5	0	0	1
R	4	5	0	4
S	5	2	0	6

	M	M	M	M
P	$\cancel{0}$	$\boxed{0}$	2	3
Q	1	$\cancel{0}$	$\cancel{0}$	$\boxed{0}$
R	$\boxed{0}$	5	$\cancel{0}$	3
S	1	2	$\boxed{0}$	5

Column or rows with single zero is allotted first. Zeros remaining after allotment in a column or row is cancelled.
The final optimal allotment and corresponding cost is
$P \to M_2 : 6 \times 100$
$Q \to M_4 : 8 \times 100$
$R \to M_1 : 9 \times 100$
$S \to M_3 : 6 \times 100$
Total ₹2900. Choice (B)

30. Lead time : 4 weeks
order quantity : 50 Nos

Week	Requirement	Scheduled Receipts	On hand	Order release
			30	
1	25		5	
2	0	50	55	
3	15		40	50
4	10		30	
5	0		30	
6	0		30	
7	35		–5	
8	10		–15	

Order should be released during 3rd week for receipt during 7th week. Choice (B)

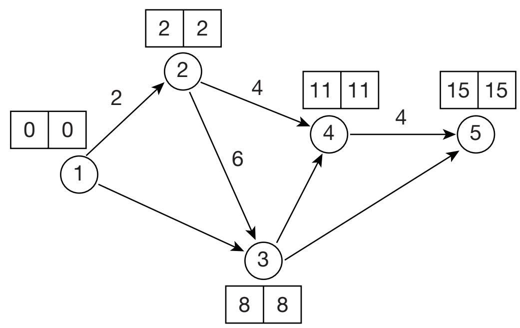
31. Arrival rate $\lambda = \frac{60}{5} = 12/\text{hr}$

Service rate $\mu = \frac{60}{3} = 20/\text{hr}$

Probability that the counter clerk is idle is

$P_0 = 1 - \frac{\lambda}{\mu} = 1 - \frac{12}{20} = 0.4.$ Choice (B)

32.



Activity	t_0	t_m	t_p	t_e	Variance σ^2 $\left(\frac{t_p - t_o}{6}\right)^2$
(1 – 2)	1	2	3	2	$\left(\frac{3-1}{6}\right)^2 = 0.111$
1 – 3	3	5	7	5	
(2 – 3)	5	6	7	6	$\left(\frac{7-5}{6}\right)^2 = 0.111$
2 – 4	2	4	6	4	
(3 – 4)	2	3	4	3	$\left(\frac{4-2}{6}\right)^2 = 0.111$
3 – 5	4	6	8	6	
(4 – 5)	2	4	6	4	$\left(\frac{6-2}{6}\right)^2 = 0.444$

Expected durations of the activities are found out using the relation

$$t_e = \frac{t_o + 4t_m + t_p}{6}$$

Critical path is found out by forward and backward pass calculations

Critical path is

1 – 2 – 3 – 4 – 5

(Activity 1 – 3, 2 – 4 and 3 – 5 are not critical as they have floats)

Critical path durations is

2 + 6 + 3 + 4 = 15 days.

Choice (D)

33. Variance of critical path

= 0.111 + 0.111 + 0.111 + 0.444

= 0.777

Standard deviation of critical path

$= \sqrt{Variance}$

$= \sqrt{0.777} = 0.8815.$

Choice (A)

34. Arrival rate $\lambda = 8/\text{hr}$

Service rate $\mu = \frac{60}{5} = 12/\text{hr}$

Average number of trucks waiting

$$N_\omega = \frac{\lambda^2}{\mu(\mu - \lambda)}$$

$$= \frac{8^2}{12(12-8)}$$

$$= \frac{64}{48}$$

= 1.333. Choice (D)

35. Average waiting time

$$T_\omega = \frac{N_\omega}{\lambda}$$

$$= \frac{1.333}{8}\ \text{hr}$$

= 10 minutes. Choice (A)