INDUSTRIAL ENGINEERING TEST 1

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

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

1. In a transportation problem, North-West corner rule would yield
(A) An optimum solution
(B) An initial feasible solution
(C) A Vogel's approximate solution
(D) A minimum cost solution

2. A type of layout suitable for use of the concept, principles and approaches of 'group technology' is
(A) Product layout (B) Job-shop layout
(C) Fixed position layout (D) Cellular layout

3. Time estimates of a project activity are optimistic time = 15 days, most likely time = 20 days, pessimistic time = 27 days.
Variance in days for this activity as per BETA distribution is
(A) 4 (B) 7
(C) 5 (D) 12

4. If orders are placed once a day to meet an annual demand of 180000 units, then the average inventory would be (assume 300 working days in a year)
(A) 200 (B) 300
(C) 250 (D) 600

5. A plumber finds that the time spent on his jobs has an exponential distribution with mean 30 minutes. If he repairs sets in the order in which they come in, and if the arrival of sets is approximately Poisson with an average rate of 10 per-hour day, then the expected number of jobs are
(A) 2 (B) 4
(C) 1 (D) 1.5

6. If the fixed cost of the assets for a given period becomes thrice, then how much will the break-even quantity become?
(A) thrice the original value
(B) same as the original value
(C) $\frac{1}{3}$ times the original value
(D) six times the original value

7. If difference of demand and forecast is 50 in the month of May then the running sum of forecast error will be
(A) 0 (B) 25
(C) 50 (D) 12.5

8. When solving the problem by Big-M method, if the objective functions row (evaluation row) shows optimality but one or more artificial variables are still in the basic, what type of solution does it show?
(A) Infeasible solution
(B) Optimal solution
(C) Degenerate solution
(D) Pseudo optimal solution

9. If lead time increases from 5 to 10 days, ordering cost becomes double and holding cost becomes one fourth, then in the basic *EOQ* model, the *EOQ* will be
(A) double
(B) increase by factor of four
(C) remains same
(D) not possible

10. The variable cost per unit associated with automated assembly line (V_A), cellular manufacturing (V_B), and job shop production (V_C) will be such that
(A) $V_A > V_B > V_C$ (B) $V_B > V_A > V_C$
(C) $V_C > V_B > V_A$ (D) $V_C > V_A > V_B$

11. Match List-I with List-II and select the correct answer using the codes given below the lists.

	List - I		List - II
P.	Transportation problem	1.	Critical path
Q.	Assignment problem	2.	Stage coach
R.	Dynamic problem	3.	Vogel's approximate method
S.	PERT	4.	Hungarian method

Codes:

	P	*Q*	*R*	*S*
(A)	2	1	3	4
(B)	3	4	2	1
(C)	2	4	3	1
(D)	3	1	2	4

12. A shopkeeper sells a fan at ₹1800 and makes 80% profit on his investment. If he sell the fan at ₹400 more, then the profit as percentage of investment will be
(A) 140 (B) 180
(C) 160 (D) 100

13. Consider the following statement
1. In an L.P model, the optimal condition can be changed when non-binding constraints are deleted.
2. Redundant constraints represent abundant resources.
(A) Both 1 and 2 are false. (B) Both 1 and 2 are true
(C) 1 is true but 2 is false (D) 2 is true but 1 is false

14. Customers arrive at a sales counter manned by a single person according to a Poisson process with a mean rate of 31 per hour. The time required to serve a customer has an exponential distribution with a mean of 100 seconds. The average waiting time of a customer in the queue will be
(A) 225 seconds (B) 500 seconds
(C) 250 seconds (D) 720 seconds

15. During an iteration while moving from one solution to the next, degeneracy may occur when
(A) the closed path indicates a diagonal move.
(B) two or more occupied cells are on the closed path but neither of them represents a corner of the path.
(C) two or more occupied cells on the closed path with minus sign are tied for lowest circled value.
(D) either of the above.

16. Consider the following equations.
Maximum profit (z) = $40x_1 + 100x_2$
$12x_1 + 6x_2 \le 3000$
$4x_1 + 10x_2 \le 2000$
$2x_1 + 3x_2 \le 900$
and $x_1, x_2 \ge 0$
The maximum profit is
(A) 10000 (B) 25000
(C) 8000 (D) 20000

17. Two tools are under consideration for a turning operation to make a particular part. Tool A costs ₹1000 and has operating cost of ₹0.15 per part. Tool B costs ₹1400 and has operating cost of ₹0.10 per part. The quantity of parts to be manufactured at which either tool will prove equally costly is
(A) 3200 (B) 1600
(C) 4000 (D) 8000

18. A dealer supplies the following information with regard to a product dealt in by him:
Annual demand = 20000 units; Ordering cost = ₹12 per order; Product price = ₹20 per unit; Inventory carrying cost = 20% of the value of inventory per year.
The dealer is considering the possibility of allowing some back order (stock out) to occur. He has estimated that the annual cost of backordering will be 30% of the value of inventory. What quantity of the product should be allowed to be back-ordered?
(A) 179 (B) 133
(C) 212 (D) 267

19. A company has 4 jobs to be done. The following matrix shows the time (in hours) that each machine takes to do each job. Find the assignment of machine to job that will minimize the total time taken.

Machine \ Jobs	1	2	3	4
P	12	30	21	15
Q	18	33	9	31
R	44	25	24	21
S	23	30	28	14

(A) $P-1, Q-2, R-3, S-4$
(B) $P-1, Q-3, R-2, S-4$
(C) $P-2, Q-1, R-3, S-4$
(D) $P-2, Q-3, R-1, S-4$

20. A set of jobs are to be machined on a single machine. By Shortest Processing Time (SPT) rule, calculate the average number of job in the system.

Jobs	Processing Time	Due Date
P	10	34
Q	8	32
R	16	46
S	6	36
T	18	64
U	12	41

(A) 33.67 (B) 2.9
(C) 70 (D) 202

21. Match List-I (Methods) with List-II (Problems) and select the correct answer using the codes given below the lists:

List - I	List - II
P. Moving average	1. Assembly
Q. Line balancing	2. Purchase
R. Economic batch size	3. Forecasting
S. Jhonson algorithm	4. Sequencing

Codes:

	P	Q	R	S
(A)	1	3	2	4
(B)	1	3	4	2
(C)	3	1	4	2
(D)	3	1	2	4

22. A dealer for television forecasts the demand at the rate of 500 units per month, for the next four months. The actual demand is found to be 400, 560, 700 and 800 units. The mean absolute deviation (MAD) and the BIAS are found to be
(A) 165 and -115 (B) 330 and -230
(C) 165 and 115 (D) 330 and 230

23. If fixed cost = ₹10000, total variable cost = ₹16000, total sales = ₹32000 and units sold = 10000, then the volume of sale to earn profit of ₹8000 will be
(A) 5625 (B) 8000
(C) 6410 (D) 7245

24. Find the initial basic feasible solution of the following transportation problem by Unit Cost Penalty method.
Destination

Orgin \ Destination	1	2	3	4	Supply ↓
A	2	3	11	7	1
B	1	0	6	1	6
C	5	8	15	9	10
Demand →	7	5	3	2	

(A) 112 (B) 116
(C) 108 (D) 102

25. The demand for a product in the month of September turned out to be 50 units against an earlier made forecast of 50 units. The actual demand for October and November turned to be 55 and 56 units respectively.

What will be the forecast for the month of December, using exponential smoothing method and taking smoothing constant (α) as 0.25?

(A) 50 units (B) 52.44 units
(C) 54.44 units (D) 55.75 units

26. Consider the following statements with respect to PERT.

1. It consists of activities with uncertain time hases.
2. This is evolved from Gantt chart.
3. Total slack along the critical path is not zero.
4. There can be more than one critical path.

(A) 1, 2 (B) 2 only
(C) 4, 2 (D) 3, 2

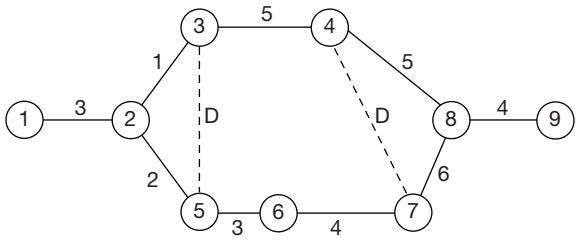
27. A time standard for a data entry clerk is to be set. A job is rated at 140 percent, it takes 35 seconds to enter each record and the allowances are 15%. What is the normal time?

(A) 35 seconds (B) 40 seconds
(C) 49 seconds (D) 50 seconds

28. Consider a single server queuing model with Poisson arrival (λ = 5/hr) and exponential service (μ = 5/hr). The number in the system is restricted to a maximum of 20. What is the probability that a person who comes in leads without joining the queue?

(A) 1/21 (B) 1/11
(C) 1/20 (D) 1/10

29. In the network shown below, the critical path is along



(A) 1 – 2 – 3 – 4 – 8 – 9
(B) 1 – 2 – 3 – 5 – 6 – 7 – 8 – 9
(C) 1 – 2 – 3 – 4 – 7 – 8 – 9
(D) 1 – 2 – 5 – 6 – 7 – 8 – 9

30. When the annual demand of a product is 50000 units, the *EOQ* is 3000 units. If the annual demand is 100000 units, the most appropriate *EOQ* will be

(A) 1500 units (B) 4200 units
(C) 3000 units (D) 6000 units

31. A regression model is used to express a variable *Y* as a function of another variable *X*, this implies that

(A) A value of *X* may be used to estimate a value of *Y*.
(B) Values of *X* exactly determines value of *Y*.
(C) There is casual relationship between *Y* and *X*.
(D) There is no causal relationship between *X* and *Y*.

Common Data Questions 32 and 33:

A carpenter uses rivets at an constant rate of 8000 units per year. The rivets cost ₹ 25 per unit and the shop personnel estimate that it costs ₹ 300 to place an order, and the carrying cost of inventory is 12% per year.

32. How frequently should order for rivets be placed (units/year)?

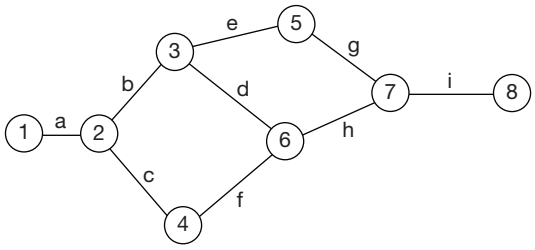
(A) 5 (B) 8
(C) 7 (D) 4

33. If the actual costs are ₹600 to place an order and 16% for carrying cost, the optimum policy will change. How much is the company losing per year because of imperfect cost information?

(A) ₹1965 (B) ₹3596
(C) ₹2402 (D) ₹2109

Linked Answer questions 34 and 35:

Consider a PERT network for a project involving 9 task (a to i)



Activity	Expected task time (in days)	Variance of task time (days²)
a	6	0.45
b	8	2.8
c	8	1.8
d	20	2.8
e	18	7.2
f	10	1.8
g	8	1.8
h	2	0.12
i	7	0.12

34. The expected completion time of the project is

(A) 47 days (B) 51 days
(C) 49 days (D) 48 days

35. The probability of completing the project in 47 days

(A) 0 (B) 83.34%
(C) 100% (D) 50%

Answer Keys

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

Hints and Explanations

1. Choice (B)

2. Choice (D)

3. Variance, $\sigma^2 = \left[\frac{t_p - t_o}{6}\right]^2$

$= \left[\frac{27-15}{6}\right]^2 = 4$ Choice (A)

4. Orders per year = 300

Ordered quantity, $Q = \frac{180000}{300} = 600$ units

Average inventory $= \frac{Q}{2} = 300$ units Choice (B)

5. $\mu = \frac{1}{30}, \lambda = \frac{10}{10\times 60} = \frac{1}{60}$

$\therefore$ Expected number of job, $L_s = \frac{\lambda}{\mu - \lambda}$

$\Rightarrow L_s = \frac{\frac{1}{60}}{\frac{1}{30} - \frac{1}{60}} = 1$ job Choice (C)

6. Break even quantity, $x = \frac{F}{S - V}$

F = Fixed cost; V = Variable cost

S = Selling cost

$\therefore$ When F becomes $3F$ then x also becomes $3x$.

Choice (A)

7. $RSFE = \frac{(D_t - F_t)}{1} = 50$ Choice (C)

8. Choice (A)

9. $(EOQ)_1 = \sqrt{\frac{2DF}{C}}$

$(EOQ)_2 = \sqrt{\frac{2\times D\times 2\times F}{C/4}} = 4\times\sqrt{\frac{2DF}{C}} = 4(EOQ)_1$

Choice (B)

10. Choice (C)

11. Choice (B)

12. Profit $= \frac{\text{S.P} - \text{C.P}}{\text{C.P}}$

$0.8 = \frac{1800 - \text{C.P}}{\text{C.P}} \Rightarrow \text{C.P} = ₹1000$

Now, Profit $= \frac{2400 - 1000}{1000} = 140\%$ Choice (A)

13. Choice (D)

14. $\lambda = 31$ per hour; $\mu = \frac{60\times 60}{100} = 36$ per hour

$\therefore$ Average waiting time of a customer in the queue is given by $W_q = \frac{\lambda}{\mu(\mu - \lambda)} = \frac{25}{36(36-31)}$

$\Rightarrow W_q = \frac{5}{36}$ hour

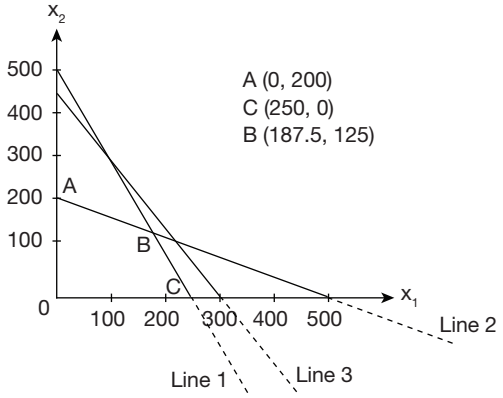
$\Rightarrow W_q = 500$ seconds Choice (B)

15. Choice (C)

16. $\frac{x_1}{250} + \frac{x_2}{500} = 1$ --------- Line 1

$\frac{x_1}{500} + \frac{x_2}{200} = 1$ --------- Line 2

$\frac{x_1}{450} + \frac{x_2}{300} = 1$ -------- Line 3



For maximum profit

$Z_A = Z_B = 20000$ Choice (D)

17. $1000 + 0.15\,Q = 1400 + 0.10\,Q$

$\Rightarrow 0.05\,Q = 400$

$\Rightarrow Q = 8000$ Choice (D)

18. Economic ordered quantity when back ordering is permitted

$$Q=\sqrt{\frac{2DC_o}{C_h}\left[\frac{C_h+C_b}{C_b}\right]}$$

C_h = 20% of ₹20 = ₹4 per unit per year
C_o = ₹12 per order
C_b = 30% of ₹20 = ₹6 per unit per year
D = 20000 units

$$\Rightarrow \quad Q=\sqrt{\frac{2\times20000\times12}{4}\left[\frac{4+6}{6}\right]}$$

$\therefore$ Q = 447.21 units

Optimum quantity of the product to be back-ordered is

$$S=Q\left[\frac{C_h}{C_h+C_b}\right]=447.21\left[\frac{4}{6+4}\right]$$

S = 179 units Choice (A)

19. Step-1: Checking of square matrix
Step-2: Subtracting smallest element of each row from every element of corresponding row

	1	2	3	4
P	0	18	9	3
Q	9	24	0	22
R	23	4	3	0
S	9	16	14	0

Step-3: Subtracting the smallest element of each column from every element of corresponding columns.

	1	2	3	4
P	0	14	9	3
Q	9	20	0	22
R	23	0	3	0
S	9	12	14	0

Step-4: Making assignments. (Hungarian method)

	1	2	3	4
P	[0]	14	9	3
Q	9	20	[0]	22
R	23	[0]	3	
S	9	12	14	[0]

$\therefore$ Assignment → P-1, Q-3, R-2, S-4 Choice (B)

20.

Job	Processing Time	Due Date	Job flow time
D	6	36	6
B	8	32	14
A	10	34	24
F	12	41	36
C	16	46	52
E	18	64	70

Average number of jobs in system

$$=\frac{6+14+24+36+52+70}{70}$$

= 2.8857 ~ 2.9 Choice (B)

21. Choice (D)

22.

Actual Demand (D)	Forecasted Demand (F)	(D-F)
400	500	-100
560	500	60
700	500	200
800	500	300

n = 4

$$MAD=\frac{\sum_{i=1}^{n}|D-F|}{n}=\frac{(100+60+200+300)}{4}=165$$

$$BIAS=\frac{\sum_{i=1}^{n}(D-F)}{n}=\frac{(-100+60+200+300)}{4}=115$$

Choice (C)

23. F = ₹10000

$$v=\frac{16000}{10000}=₹1.6/\text{units}$$

$$s=\frac{32000}{10000}=₹3.2/\text{units}$$

Volume of sale (Q) to earn profit of ₹8000 is

$$Q=\frac{F+P}{s\text{-}v}=\frac{1000+8000}{3.2\text{-}1.6}=5625 \text{ units}$$ Choice (A)

24.

					Supply	Penalties
	$2_{(1)}$	$3_{(5)}$	11	7	6/1	1/1/5
	1	0	6	$1_{(1)}$	1/0	1
	$5_{(6)}$	8	$15_{(3)}$	$9_{(1)}$	10/4/3	3/3/4/4
Demand →	$\frac{7}{6}{0}$	$\frac{3}{5}$	$\frac{3}{0}$	$\frac{2}{1}{0}$		
Penalties →	$\frac{1}{3}{3}$	$\frac{3}{5}$	$\frac{5}{4}{4}$	$\frac{6}{2}{2}$		

Total Cost = (2 × 1) + (3 × 5) + (1 × 1) + (5 × 6) + (15 × 3) + (9 × 1) = ₹102 Choice (D)

25. $F_{\text{October}} = \alpha D_{\text{September}} + (1-\alpha)F_{\text{September}}$
$= (0.25 \times 50) + (0.75 \times 50) = 50$ units
$F_{\text{November}} = \alpha D_{\text{October}} + (1-\alpha)F_{\text{October}}$
$= (0.25 \times 55) + (0.75 \times 50) = 51.25$ units
$F_{\text{December}} = \alpha D_{\text{November}} + (1-\alpha)F_{\text{December}}$
$= (0.25 \times 56) + (0.75 \times 51.25) = 52.44$ units

Choice (B)

26. Choice (C)

27. Normal time = Observed time × Rating factor
= 35 × 1.4 = 49 seconds Choice (C)

28. $\rho = \frac{\lambda}{\mu} = \frac{5}{5} = 1$

$P_0 + P_1 + P_2 + \ldots\ldots + P_{20} = 1$

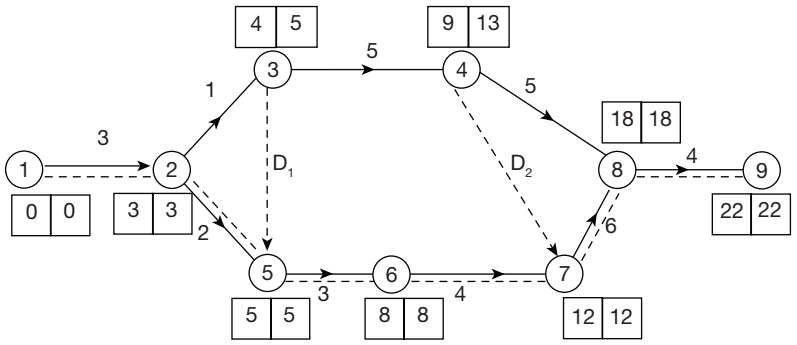
$P_0 + \rho P_0 + \rho^2 P_0 + \ldots\ldots + \rho^{20} P_0 = 1$

$P_0(1 + 1 + 1 + \ldots\ldots + 1) = 1$

$P_0 = 1/21$

$P_n = P^n P_0 = (1)^{21} \frac{1}{21} = 1/21$ Choice (A)

29.



Critical Path = 1 – 2 – 5 – 6 – 7 – 8 – 9 Choice (D)

30. $EOQ_1 = \sqrt{\frac{2DF}{C}} = 3000$

$EOQ_2 = \sqrt{\frac{2(2\times D)\times F}{C}} = \sqrt{2} \times \sqrt{\frac{2DF}{C}}$

$\therefore EOQ_2 = \sqrt{2} \times EOQ_1$

$= \sqrt{2} \times 3000$

= 4200 units Choice (B)

31. Choice (A)

32. Demand, D = 8000 units
Cost, C = ₹25/unit
Holding Cost, C_h = 0.12 × 25
= ₹3/unit/year
Ordering cost, C_o = ₹300/order

$EOQ(Q) = \sqrt{\frac{2DC_o}{C_h}} = \sqrt{\frac{2\times 8000\times 300}{3}}$

$\Rightarrow$ Q = 1265 units

Optimum number of order = $\frac{D}{Q} = \frac{8000}{1265} = 6.33 \sim 7$

Choice (C)

33. Total inventory Cost = $\sqrt{2DC_oC_h}$

$= \sqrt{2\times 8000\times 300\times 3}$

= ₹3795

Now C_o = ₹600/order, C_h = 0.16 × 25
= ₹4/unit/year

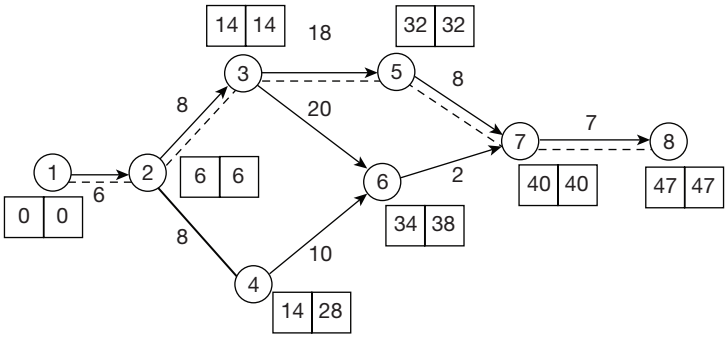
Total inventory Cost = $\sqrt{2DC_oC_h}$

$= \sqrt{2\times 8000\times 600\times 4}$

= ₹6197

Loss per year due to imperfect information
= 6197 – 3795
= ₹2402 Choice (C)

34.



Expected time of completion = 47 days Choice (A)

35. Probability of completing the project in 47 days is

$Z = \frac{47-47}{\sigma} = 0$ $P(Z = 0) = 50\%$ Choice (D)