

(3 hours) [Total Marks-80]

- N.B. (1) Attempt any four questions out of six questions
 (2) Assume any additional data if necessary and state it clearly
 (3) Explain answers with neat sketches wherever necessary

1. a) Trains X and Y arrive at a station at random between 11 am and 11.20 am. Train X stops for 5 minutes and Train Y stops for 4 minutes. Assuming that both trains arrive independently of each other, what is the probability that [07]
 b) Based on a 360° appraisal, a project manager's performance was evaluated based on ranks obtained for some parameters, on his previous projects as given in Table below. [05]
 The ranks were given from 1 to 5

Sr. No	Parameter	Peer Review	Self-Appraisal
1	Contribution to timely completion of project	4	2
2	Cost control	5	3
3	Prevention of Rework	3	2
4	Litigation (Dispute prevention)	3	2
5	Quality	4	4

Determine Spearman's rank correlation coefficient for the above scenario

- c) A tenderer is bidding for construction works, averagely 5 nos. in a year for the past 5 years. Find the probability that: [08]
 (i) He gets atleast 4 works (ii) He gets exactly 3 works
 (iii) He does not get any work (iv) He does not get more than 2 work
 Also find the mean, standard deviation, variance and frequency of 'r' successes of the above scenario
2. a) Explain application of Cox Model, Nunally and Vorster-Sears models in predicting and controlling construction equipment breakdown costs with practical examples [10]
 b) Explain different types of risks and uncertainties associated with construction projects with practical examples and elaborate on how and which mathematical tools will enable project managers to predict and hence mitigate these risk. [10]
3. a) Table below gives the weights of various contents in 10 concrete mixes used for construction on site. [10]

Sr. No.	Cement content (X) (kg/m ³)	W/C ratio (Y)	Compressive strength (Z) (N/mm ²)
1	343	0.467	35.2
2	342	0.462	35.5
3	351	0.455	36.7
4	338	0.452	34.2
5	345	0.453	36.0
6	347	0.456	36.3
7	351	0.459	37.5
8	349	0.453	36.9
9	362	0.440	38.4
10	346	0.454	35.8

Find out the Karl-Pearsons Simple co-relation coefficient that exists between:

- (i) Cement content(X) and W/C ratio(Y)
 (ii) Cement Content(X) and Compressive strength(Z)

(iii) W/C ratio(Y) and Compressive strength(Z)

Also check for probable error and find coefficient of determination. Comment on the physical significance of C.D obtained

- b) Four machines regularly produce similar products on an automated production line. [10]
Machine 1, which manufactures 30% of the products, produces a defective product 1 times in 10; Machine 2, which manufactures 50% of the products, produces a defective product 1 times in 20; Machine 3, which manufactures 15% of the products, produces a defective product 1 times in 15. Machine 4, which manufactures 5% of the products, produces a defective product 1 times in 10; If, during random inspection, one product is selected at random, what is the probability that the selected product is defective? Also find the probability, if the product is defective, what is the probability that it has come from Machine 4?

4. a) In the gradation process of construction contractors, adopted by Construction Industry Development Council(CIDC), based on budget and schedule achievement, contractor's organizations were rated on a scale of 1 to 5 (1 being poor, 5 being excellent), based on their performance. [08]

A reputed construction firm, based on execution of 10 of its similar industrial projects, has got the following ratings

CIDC rating for project performance

Project no.	Rating for performance (maintaining Schedule)	Rating for performance (maintaining Budget)
1	5	3
2	4	3
3	4	3
4	5	5
5	1	1
6	2	3
7	5	2
8	5	1
9	1	2
10	3	4

Determine the mean and standard deviation values for ratings given for budget and schedule achievements. Assuming Normal distribution, determine the probability of the construction company getting grades between 3 and 5 for its future projects

- b) Decide the optimum no. of associated units for the prime mover based on the [12]
following data:
(i) Mean cycle time of the prime mover = 3.5 minutes
(ii) Mean haul time of the associated unit = 10 minutes
(iii) Haul Unit capacity – 5 cu.m.
(iv) Hourly cost of prime mover, $C_P = \text{Rs. } 5000/-$
(v) Hourly cost of associated unit, $C_A = \text{Rs. } 650/-$

Based on conventional practice, for this work, 5 associated units were assigned. Using Griffi's waiting line model, decide whether the associated units assigned are optimum or adding unnecessary.

- 5 You are the materials manager of a very reputed construction company. On a [20]
prestigious construction project, it is estimated that your company requires 1.5 lakh cement bags annually. Basic Unit price of cement bags is Rs. 350/bag. The ordering cost is Rs. 3000/order. Inventory Carrying cost is 20% of average annual inventory. Based on activity scheduling, monthly requirement is as follows:

Turn Over

Monthly estimated requirement

Sr. No.	Month	No. of bags required (in thousand)
1	Jan	12
2	Feb	13
3	Mar	20
4	Apr	26
5	May	31
6	Jun	10
7	Jul	7
8	Aug	4
9	Sep	5
10	Oct	9
11	Nov	10
12	Dec	3

Suppliers have offered discounts on bulk purchases.

Discounts offered

Sr. No.	No. of bags	Discount
1	50,000 and above	10
2	30,000 to 49,999	7
3	20,000 to 29,999	5
4	10,000 to 19,999	3
5	5,000 to 9,999	2
6	Below 5,000	No discount

A research related to godown management has revealed that cement deteriorates after 3 months and hence is not suitable for the intended use. Also it is found that there have been thefts associated with over-storage. The overstocking cost for the above scenario were linked up with the period of cement remaining idle as follows:

Depreciation of cement

Sr. No.	1	2	3	4
Period	3 months and less	3 to 4 months	4 to 5 months	5 months and above
Depreciation	4 % of unit price	6 % of unit price	10% of unit price	15% of unit price

Another research associated with work stoppages and production delays was carried out and understocking cost was carried out and understocking cost can be considered equivalent to 10% of the cost of total cement bags causing the understocking.

Decide the order quantity to be purchased, based on uniform ordering period, so that the total cost of cement bags is minimum

Turn Over

6. a) In 10 years of a truck driver's career, it has been recorded that he has encountered 8 minor and 1 major accident. His average journey is 50 kms/day. What is the probability that, if he has embarked on a journey to deliver goods on a construction site, 100 kms from the manufacturing yard, that he will be involved in an accident [05]
- b) If 0.3% of precast elements manufactured by a factory are defective, find the probability that in a batch of 1 lakh such elements manufactured [05]
- (i) 50 elements are defective (ii) 100 elements are defective
- c) The duration of an activity depends upon the resources allocated (ultimately the total money spent) and proper utilization of these resources (Rated on a 10 point scale with higher rating meaning proper utilization) A particular construction activity has the following historical track record. [10]

Sr. No	Activity Duration (y) (days)	Funds allocated (x ₁) (Rs.)	Score for Resource Utilization(x ₂)
1	15	15,000	7
2	20	25,000	6
3	40	43,000	7
4	22	25,000	8
5	25	41,000	5
6	37	54,000	6
7	18	24,000	7
8	24	13,000	9

For the data given in Table, establish the linear regression equation linking the activity duration in days with the resources consumed and its proper utilization. Comment on the accuracy of the relationship