

- N.B. (1) Attempt any four questions out of six questions  
 (2) Assume any additional data if necessary and state it clearly  
 (3) Figures to the right indicate full marks

- 1 a) Trains X and Y arrive at a station at random between 9 am and 9.30 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 [06]  
 i. Train X arrives before Train Y  
 ii. The trains meet at the station  
 iii. Assuming that the trains meet, Train X arrived before Train Y  
 b) Based on a  $360^0$  appraisal, a project manager's performance was evaluated based on ranks obtained for some parameters, on his previous project as given in Table below. [06]  
 The ranks were given from 1 to 8

**Peer Review and Self-appraisal on previous projects**

Sr. No.	Parameter	Peer Review	Self Appraisal
1	Contribution to timely completion of project	6	2
2	Cost control	5	3
3	Prevention of Rework	3	2
4	Litigation (Dispute prevention)	7	2
5	Quality	4	3
6	Periodic Reporting to H.O.	8	6

Determine Spearman's rank correlation coefficient for the above scenario.

- c) Four machines regularly produce luxury articles on an automated production line. [08]  
 Machine 1, which manufactures 25% 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 10% of the products, produces a defective product 1 times in 25; 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 3?  
 2 a) Explain different types of risks 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 risks. [10]  
 b) A tenderer is bidding for construction works, averagely 11 nos. in a year for the past 5 years. Find the probability that: [10]  
 i. He gets atleast 9 works  
 ii. He gets exactly 4 works  
 iii. He does not get any work  
 iv. He does not get more than 2 work  
 v. He gets all the works

Also find the mean, standard deviation, variance and frequency of 'r' successes of the above scenario

3. a) Decide the optimum no. of associated units for the prime mover based on the following data: [12]  
 i. Mean cycle time of the prime mover = 4 minutes  
 ii. Mean haul time of the associated unit = 12 minutes  
 iii. Haul Unit capacity – 5 cu.m.  
 iv. Hourly cost of prime mover,  $C_P = \text{Rs. } 6000/-$   
 v. Hourly cost of associated unit,  $C_A = \text{Rs. } 700/-$

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.

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- b) In 15 years of a truck driver's career, it has been recorded that he has encountered 23 minor and 2 major accidents. 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, 25 kms from the manufacturing yard, that he will be involved in an accident
- 4 a) Table below gives the properties of 10 concrete mix batches used for construction [12]  
site.

### Data pertaining to a sample of 10 concrete mixes used for construction

Sr. No.	Cement content (X) (kg/m <sup>3</sup> )	W/C ratio (Y)	Compressive strength (Z) (N/mm <sup>2</sup> )
1	335	0.467	38.4
2	337	0.462	39.8
3	341	0.461	36.7
4	338	0.463	36.2
5	345	0.463	36.1
6	347	0.456	36.3
7	347	0.449	39.5
8	349	0.463	36.9
9	341	0.460	35.4
10	346	0.444	39.8

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

- Cement content(X) and W/C ratio (Y)
- Cement Content(X) and Compressive strength (Z)
- 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) Develop Regression equations between the 3 parameters given in question 3 b) [08]
5. You are the materials manager of a very reputed construction company. On a prestigious construction project, it is estimated that your company requires 1.6 lakh cement bags annually. Basic Unit price of cement bags is Rs. 340/bag. The ordering cost is Rs. 3000/order. Inventory Carrying cost is 22% of average annual inventory. Based on activity scheduling, monthly requirement is as follows: [20]

### Monthly estimated requirement

Sr. No.	Month	No. of bags required (in thousand)
1	Jan	25
2	Feb	26
3	Mar	20
4	Apr	23
5	May	21
6	Jun	15
7	Jul	7
8	Aug	4
9	Sep	5
10	Oct	19
11	Nov	12
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	9 % of unit price	15% of unit price	22% 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

6. a) Prepare a simulation model based on Monte-Carlo simulation to generate a range of random numbers, for the mean for the actual cost of 10 projects of similar nature as given below. Select suitable range for each. Run the simulation. (refer random number table given below) [12]

Project No.	Project cost (in Lakh Rs.)
01	41.23
02	58.71
03	62.27
04	13.48
05	88.91
06	43.01
07	49.81
08	95.22
09	18.23
10	42.28

Random Number Table

11164 36318 75061 37674 26320 75100 10431 20418 19228 91792 21215 91791  
 08882 90870 12462 41810 01806 02977 36792 26236 33266 66583 60881 97395  
 33827 92873 02953 85474 65285 97198 12138 53010 94601 15838 16805 61004  
 12645 62000 78137 98768 04689 87130 79225 08153 84967 64539 79493 74917

- b) If 0.5% of door handles manufactured by a factory are defective, find the probability that in a batch of 1 lakh such handles manufactured [08]
- i. 50 handles are defective
  - ii. 100 handles are defective
  - iii. 25 handles are defective
  - iv. No handles are defective