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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Third Semester, M. Tech - Civil Engineering (MCAD)

Semester End Examination; Dec - 2017/Jan - 2018

Reliability Analysis and Design of Structural Elements

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1. The test results of compressive strength of cube are given below :
Compute the Mean, Standard Deviation, Coefficient of Variation, Coefficient of Skewness, and Coefficient Kurtosis for the given data. Also plot histogram and cumulative frequency diagram. 20

Sl. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Cube Strength (MPa)	14.98	15.64	15.75	16.27	15.58	16.53	20.53	20.0	21.78	21.86	15.08	15.56	12.11	14.83	17.36

2. The text results of compressive strength of brick masonry are given below :
Compute the Mean, Standard Deviation, Coefficient of Variation, Coefficient of Skewness, and Coefficient of Kurtosis for the given data. Also plot the histogram and cumulative frequency diagram. 20

Sl. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Strength MPa	2.36	3.41	2.8	2.46	3.8	4.3	3.2	3.86	1.95	3.46	2.85	1.90	3.6	2.9	4.34

UNIT - II

3 a. A simply supported beam of span L is to be designed for shear. There are two loads Q_1 = 20 kN and Q_2 = 60 kN which act on the beam? These two loads act only at discrete points of 0.25 L and 0.75 L on the beam. It is not essential that both loads act on the beam at the same time. Sketch the sample space for maximum shear in the beam. 8

b. A water supply system is to be designed to meet the demand during any given summer. There are three demand levels: D_1, D_2 and D_3 being equal to $2x10^5$, $3x10^5$ and $4x10^5$ litres / day respectively. If the demand level is $2x10^5$ litres /day, probability of supply being adequate in summer is 1. The corresponding for $3x10^5$ litres /day and $4x10^5$ litres /day are 0.8and 0.6 respectively. Compute; 12
i) Probability that the supply is adequate during summer regardless of the demand level
ii) If adequate supply is seen, what is the probability that the demand level is $3x10^5$ litres /day?

4 a. Samples of soil are collected from various depths below ground level and tested in the laboratory to determine their shear strength. The collected data is given below : 15

Depth (m)	2	3	4	5	6	7
Shear Strength (kN/m^2)	14.8	20.3	32.2	39.0	42.0	56.4

Determine sample covariance and correlation coefficient between depths of soil and shear strength. What is the inference from the result?

b. Given the values of cube strength and cylinder strength as below, plot a scatter grain and write the inference from this plot. 5

Sl. No.	1	2	3	4	5	6	7	8	9	10
Cube Strength N/mm^2	15.17	17.92	20.13	22.54	24.80	18.67	22.91	27.70	29.24	18.27
Cylinder Strength N/mm^2	9.86	11.29	12.48	14.65	15.38	11.95	14.43	18.00	18.42	11.69

UNIT - III

5a. The completion of a water tank involves the successive completion of four stages,

A : excavation completed on time P(A) = 0.9

B : Foundation completed on time P(B) = 0.8

C : Columns and bracings completed on time P(C) = 0.7

D : Tank portion completed on time P(D) = 0.7 12

If the four events are independent statistically. Compute;

i) Probability of whole structure completed in time

ii) What is the probability of the tank portion completed on time and at least one of the other three events not completed on time?

b. The yield strength of steel *X*. follows Log normal distribution with mean = 1568 MPa and standard deviation = 48.8 MPa. What is the probability of getting yield strength less than 1500 MPa? 4

c. The cube strength of M35 concrete follows the normal distribution with mean = 42.28 MPa and standard deviation of 5.6 MPa. What is the probability of strength less than 35 MPa? 4

6a. There are three members in a determinate truss. The probability of failure of each member is given as $P_1 = 0.1$, $P_2 = 0.2$ and $P_3 = 0.3$. The performance of a member depends on the other members. Given $P(F_1 \mid F_2 \cap F_3) = 0.8$; $P(F_2 \mid F_3) = 0.9$. Compute the Reliability of the truss. 10

b. The probability density function of rainfall during the monsoon season is given by, 10

$P_x(x) = 32\, e^{-4x} \quad x \geq 0$. Compute mean and variance.

UNIT - IV

7a. Write a note on central moments and their significance. 8

b. A simply supported beam carries three concentrated load P_1, P_2 and P_3 at distance L/4, L/2 and 3L/4 from left hand support. Determine expected value of mean and standard deviation of shear force at left hand support given the following data:

P_1 : mean = 30 kN ; variance = 3 kN^2 12

P_2 : mean = 40 kN; variance = 4 kN^2

P_3 : mean = 25 kN; variance = 2.5 kN^2

L is the span. It is given that the loads are a dependent.

8a. A column is to be designed for a load on which is equal to its self weight 'S' and a fraction of the live load 'L' on the beam supported by the column. W is given by,

W = S+CL where C is constant which is greater than zero. Find probability density function of W given PDF of L is P_L is, 10

$$P_L(l) = \frac{1}{\sqrt{2\pi}} e^{-\left(l^2/2\right)} \quad l \geq 0.$$

b. The force in a tie member is given by, $Z = XY$, where Z is the force, X is stress and Y is area of cross section given,

$$P_X(x) = \frac{1}{8}x \qquad 0 \leq x \leq 4$$ 10

$$P_y(y) = \frac{1}{a} \qquad 0 \leq y \leq a$$

Compute PDF of Z.

UNIT - V

9 a. The strength of a column is given by $R = \frac{\pi^2 EI}{a^2}$

Where;

E is Young's modulus (mean = 2.03×10^5 MPa, COV = 0.1)

I is moment of Inertia (mean = 12.5×10^6 mm^4, COV = 0.05) 15

a is Length (Mean = 5000 mm; COV = 0.05)

The column carries a load Q with mean of 700 kN and av = 0.3. Assuming all variables to be Log normally distributed, compute the probability of failure.

b. Explain the concept of sampling and its relevance in simulation. 5

10. A cantilever beam of span L is carrying the load P at its free end. The resisting moment is taken as by Z where Fy is the yield tress and Z is the section modulus. Formulate the limit state equation in flexure. Given;

Fy (mean = 0.32 kN/mm^2, COV = 0.1) – normally distributed 20

Z (mean = 1400×10^3 mm^3; COV = 0.05) – Normally distributed

P (mean = 100 kN, COV = 0.4) – Log normally distributed.

Compute reliability index β given L = 2 m. Carry out at least two cycles.

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