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

(An Autonomous Institution affiliated to VTU, Belgaum)

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

Semester End Examination; Dec - 2016/Jan - 2017

Reliability Analysis and Design of Structural Elements

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Assume missing data if any.

UNIT - I

1 a. Find the mean, standard deviation and coefficient of variance for the grouped data given, 10

Class	1 – 10	11 – 20	21 – 30	31 – 40	41 – 50	51 – 60
Frequency	03	16	26	31	16	08

b. In a data set of n = 200 on yield strength of steel, $\bar{x}$ = 500 MPa and σ = 60 MPa. However, later on it's found that a value of 415 MPa was wrongly entered as 451 MPa. Find the corrected mean and corrected standard deviation. 10

2 a. The following table gives the strength of the concrete. Find the central moments, coefficient of skewness and coefficient of Kurtosis. 10

Compressive strength N/mm^2	60 – 62	63 – 65	66 – 68	69 – 71	72 – 74
Frequency (f_i)	05	18	42	27	08

b. The cube strength of concrete follows a normal distribution with μ_x = 30 N/mm^2 and σ_x = 45 N/mm^2, 10

Calculate: i) P (x < 25) ii) P(35 ≤ x ≤ 45).

UNIT - II

3 a. Derive the normal equation of best fit parabola by lest square method. 10

b. The data on cube strength and Cylinder strength is given below,

Cube Strength N/mm^2 (x_i)	Cylinder Strength N/mm^2 (y_i)
15.17	9.86
17.92	11.29
20.13	12.48
22.54	14.65
24.80	15.38
18.67	11.95
22.91	14.43
27.70	18.00
29.24	18.42
18.27	11.69

10

Determine the sample covariance, co-relation and coefficient between x_i and y_i.

Contd….2

4 a. The data on the compressive strength of concrete is given below:

i) Fit a straight line ii) Fit a parabola iii) Find which is better fit 12

Days (x_i)	1	3	7	10	14	21	28
Compressive strength N/mm^2 (y_i)	7.2	10.5	13.2	15.6	18.1	20.3	25.2

b. Fit a curve of the form $\boxed{y = ab^x}$ for the following data. Find the shrinkage strain when $\boxed{x = 7.5}$ 8

Days (x_i)	1	2	3	4	5	6	7	8
Shrinkage strain (y_i)	1.0	1.2	1.8	2.5	3.6	4.7	6.6	9.1

UNIT - III

5. For the following data, a log normal distribution and proposed. Find the expected frequencies that are proposed. Conduct a Chi-square test to accept (d) reject the proposal. 20

Class MPa	12 - 14	14 - 16	16 - 18	20 - 22	22 - 24	24 - 26
Frequency	16	53	88	30	15	03

6. Derive the statistics of $R = f_y A_{st}\ d\left[1 - \dfrac{0.77\, f_y A_{st}}{f_{ck} bd}\right]$

$f_y = N[425,\ 45]MPa$

$f_{ck} = N[23.2,\ 6.8]MPa$

Where $A_{st} = N[1500,\ 60]mm^2$ 20

$b = N[230,\ 12]mm$

$d = N[450,\ 15]mm$

List the variables in the order of their contribution to randomness of 'R'.

UNIT - IV

7. Determine 'β' by FOSM method by using the failure function,

i) $M = \dfrac{\pi^2 EI}{l^2} - Q$ ii) $M = I - \dfrac{Ql^2}{\pi^2 E}$

$E = N\left[2.03*10^5,\ 0.203*10^5\right]MPa$

Where $Q = N\left[700*10^3,\ 210*10^3\right]N$ 20

$I = N\left[12.5*10^6,\ 0.0625*10^6\right]mm^4$

$l = N[5000,\ 150]mm$

Check whether β is Invariant (or) not Invariant.

Contd….3

8. The failure function $\boxed{g(x) = d - \frac{Q}{2 f_s t_w}}$

$Q = N[4200,\ 1000]N$

$f_s = N[95,\ 10]N/mm^2$

Where $d = N[50,\ 2.5]mm$

$\sigma_{tw} = 0, \quad \frac{d}{t_w} = 40$

20

Find the reliability Index 'β' by AFOSM method. Use Harofer-Lind approach.

UNIT - V

9. A short column has a diameter X_1 and is loaded with an axial load X_2. The ultimate compressive stress of column is X_3. The variables are normally distributed and have the following statistics.

$X_1 = N(3.5,\ 0.4) \qquad X_2 = N(10,\ 10) \qquad X_3 = N(2.5,\ 0.5)$

$\boxed{g(x) = \frac{\pi X_1^2}{4} - \frac{X_2}{X_3} = 0}$

20

Find 'β' by AFOSM method using Fisseler's algorithm.

10. The strength of an axially loaded column is given by,

$\boxed{R = 82912.5 f_{ck} + 1250 f_y}$

Where $f_{ck} = N[19.54, 4.1]\ \ N/mm^2$, $f_y = N[469, 46.9]\ \ N/mm^2$ Generate the statistics of $'R'(n = 20)$. The column is subjected to an axial load of $S = N[2100,\ 500]kN$. Generate statistics of $(R - S)$ by Monte Carlo simulation technique. Find the probability of failure of column, by counting negative values of $(R - S)$.

20

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