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

(An Autonomous Institution affiliated to VTU, Belagavi)

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

Semester End Examination; April / July - 2021

Reliability Analysis and Design of Structural Elements

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Apply statistical principles for analyzing randomness in variables.

CO2: Test goodness of fit of distribution in the data.

CO3: Adopt different acceptance and rejection tests for strength and other parameters of measurements.

CO4: carry out reliability analysis and compute reliability index for the given design details.

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

II) *Any* ***THREE*** *units will have internal choice and remaining* ***TWO*** *unit questions are compulsory.*

III) *Each unit carries 20 marks.* ***IV)*** *Missing data, if any, may suitably be assumed.*

V) *Use of statistical tables allowed.*

Q. No.	UNIT - I	Marks	BLs	COs	POs
1 a.	The following are the results obtained in an experiment. Calculate the mean, standard deviation and coefficient of variation. Plot a histogram. Determine the chance of getting a value less than 6.	10	L4	CO1	PO1,2

2	7	9	10	20	21	22	13	14	13	19	26	28	15	16

b.	Calculate the correlation coefficient between X and Y for the following data. What do you infer?	10	L4	CO1	PO1,2

x	5	15	18	20	25	25	30	34	38	50
y	45	32	37	33	24	29	26	22	24	15

OR

1 d.	List the properties of; i) Normal distribution ii) Log normal distribution	10	L1	CO1	PO1,2
e.	The mean strength of weld is 1.2 kN/mm^2 and its standard deviation is 0.4 kN/mm^2. If the weld is designed for strength of 1.5 kN/mm^2, what is the probability of survival of the welds? If the weld follows: i) Normal distribution ii) Log normal distribution	10	L4	CO1	PO1,2

UNIT - II

2 a.	Fit a straight line for the following data:	10	L4	CO2	PO1,2

x	71	68	73	69	67	65	66	67
y	69	72	70	70	68	67	68	64

Contd… 2

b. Find the least square polynomial approximation of degree two for the following data:

x	0	1	2	3	4
y	–4	–1	4	11	20

10 L4 CO2 PO1,2

UNIT - III

3 a. A simply supported beam of span 'l' is under a uniformly distributed load of 10 kN/m. Establish the statistics of maximum bending moment. Given: $l = N(5.3, 0.2)$ *m* and $W = N(25.5, 5.7)$ *kN/m*. 10 L4 CO3 PO1,2

b. A Cantilever beam of span 'l' is subjected to a point load 10 kN at the free end. Establish the statistics of maximum deflection. Given; $W = N(20, 5)$ kN, $l = N(2.7, 0.1)$ m, $E = N(2\times10^5, 0.2\times10^5)$ N/mm^2 $I = N(5400\times10^6, 270\times10^6)$ mm^4 10 L4 CO3 PO1,2

UNIT - IV

4 a. A steel beam, whose cross section is classified as a compact section, this implies that its moment carrying capacity is the plastic moment computed as $M_p = f_y \times Z$, where Z=plastic section modulus and f_y = yield strength. The total load effect is denoted by M, which is the maximum moment demand on the beam due to the applied loading. The strength limit state function is $g(x) = f_y.Z - M$. Solve the problem by FOSM method and compute;

i) Reliability index ii) The risk or Probability of failure

Given;

Variable	Mean	Standard deviation
f_y	275.8 N/mm^2	34.475 N/mm^2
Z	819353.2 mm^3	40967.66 mm^3
M	1.1298×10^8 N-mm	22.596×10^6 N-mm

10 L4 CO4 PO1,2

b. A tension element of circular cross section subjected to external load. The limit state function $g(x) = f_y.\ A - P$. Solve the problem by FOSM method compute the reliability index, probability of success and probability of failure. Given;

Variable	Mean	Standard deviation
Load P(N)	2.6689×10^4	1.7774×10^3
Yield f_y (N/mm^2)	1.0755×10^9	2.9576×10^7
Diameter d(m)	0.5842×10^{-2}	0.0759×10^{-3}

10 L4 CO4 PO1,2

OR

Contd… 3

4 d. Determine the reliability index of a simply supported beam of span '*l*' subjected to uniformly distributed load *w/m* at the limit state of flexure. The failure surface is given by,

$g(x) = f_y . Z - \frac{wl^2}{8}$. Solve the problem by Hasofer-lind method. Perform one complete iteration. Given;

20 L4 CO4 PO1,2

Variable	Mean	Standard deviation
Characteristic f_y strength $N(mm^2)$	272.41	13.62
Section modulus $Z(mm^3)$	3662.48×10^3	366248
Load w (N/m)	20.052	3.008
Span L (mm)	7082.54	354.13

UNIT - V

5 a. The strength of an axially loaded short column is given by $R = 0.67C.A_c + A_s.F$. Where C is the cube strength of concrete. F is the yield strength of steel. A_c is the area of steel. Generate the statistics of R (10 values). Compare the values with the theoretical values also find the percentage error. Given;

20 L4 CO4 PO1,2

Variable	Mean	Standard deviation
$C(N/mm^2)$	19.54	4.1
$F(N/mm^2)$	469	46.9
A_c (mm^2)	125000	-
A_s (mm^2)	1250	-

OR

5 d. The strength of an axially loaded column is given by $R = A_c .c + A_s F$ Where C is the cube strength of concrete. F is the yield strength of steel. A_c is the area of concrete and A_s is the area of steel. The column is subjected to an axial load $Q = N$ (1800, 540) kN. Generate the statistics of R and S (10 values) count the number of failures. Also find probabilities of failure. Given;

20 L4 CO4 PO1,2

Variable	Mean	Standard deviation
$C(N/mm^2)$	19.5	4.1
$F(N/mm^2)$	485	50
A_c (mm^2)	135000	500
A_s (mm^2)	1250	25

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