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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; June -2022

Reliability Analysis and Design of Structural Elements

Time: 3 hrs *Max. Marks: 100*

Course Outcome

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 measurement.

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.	Questions	Marks	BLs	COs	POs
	UNIT - I	**20**			
1 a.	The field data of soil samples collected from various depths is given below;				

Depth (m)	2	3	4	5	6	7
Shear strength (kN/m^2)	14.8	20.3	32.2	39.0	42.0	56.2

Obtain the covariance, correlation coefficient between depth and soil shear strength. | 20 | L4 | CO1 | PO1,2

OR

1 b.	With relevant expression, define normal, log normal and Gama distribution. Mention their applications.	20	L1	CO1	PO1,2
	UNIT - II	**20**			
2 a.	A simply supported beam is subjected loads P_1 and P_2 and P_3 as shown in Fig Q (2a).				

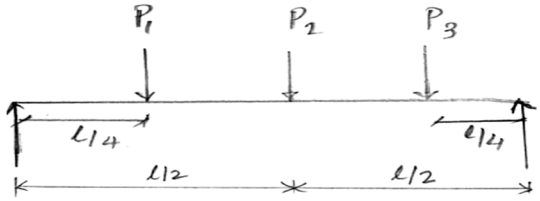

Fig. Q (2.a). | 12 | L3 | CO1 | PO1,2

It is given that $E(P_1) = 20$ kN $V_{ar}(P_1) = 2(kN)^2$

$E(P_2) = 40$ kN $V_{ar}(P_2) = 4(kN)^2$

$E(P_3) = 50$ kN $V_{ar}(P_3) = 10(kN)^2$

Contd… 2

Determine the expected value and standard deviation of the shear force at the left end, if

i) Loads P_1, P_2 and P_3 are statically independent

ii) If loads are correlated with correlation coefficients.

$\rho_{12} = 0.7, \quad \rho_{23} = 0.8, \quad \rho_{51} = 0.6$

b. Discuss briefly the various sources of uncertainty during the amount of performance of a structure. Also plot the various reliability distributions. Hence define reliability and hazard function. — 8 — L2 — CO1 — PO1,2

UNIT - III — **20**

3 a. It is given that the ratio of the mean value of the cube strength of M20 concrete to its characteristic strength is 1.4 and the coefficient of variation of the strength is 0.18. Determine the allowable stress for the probability of failure of concrete equal to 10^{-3} and k = –3.09. — 8 — L2 — CO3 — PO1,2

b. From the statistical analysis of live load survey, it is found that live load follows the log normal distribution with parameters.

$\tilde{L} = 1217\ N/m^2 \quad \sigma_{\ln L} = 0.368$

Determine the characteristic load for P_k =0.05. if, — 12 — L2 — CO3 — PO1,2

i) There is no change in tenancy

ii) The building is going to be occupied by 5 tenants during the life time of the building

UNIT – IV — **20**

4 a. A steel beam, whose cross section is classified as compact section, this implies that its moment carrying capacity is the plastic moment computed as $M_P = f_y z$, where Z = plastic section modules and f_y yield strength. M, the total load effect. Which is the maximum moment demand on the beam due to the applied loading? The strength limit state function is $g(x) = f$, z-m. Give the following data: — 20 — L3 — CO4 — PO1,2

μ_{fy} =275.8 N/mm^2 , μ_z = 819353.2 mm^2, $\mu_m = 1.1298 \times 10^8$ N-mm

$(cov)_{fy} = 0.125$, $(cov)_z = 0.05$ &$(cov)_m = 0.2$ respectively.

Solve the problem by FOSM method and compute reliability index (β), the resistance factor (ϕ), the load factor (γ) and the risk or probability of failure (P_f).

OR

Contd… 3

4 b.	Determine the reliability index for a simply supported beam for the the limit state of shear $g(x) = \tau_s\ t_w d - 0.5P$. The beam is subjected to point load P at the mid-span, where "d" is depth of the beam, t_w is the thickness of the beam τ_s is the shear strength of the material. μ_p = 4000 N, σ_p=1000 N, $\mu_{\tau s}$ = 95 N/mm^2, $\sigma_{\tau s}$ = 10 N/mm^2, μ_d =50 mm, σ_d = 2.5 mm and $d/t_w = 40$. Solve the problem by FOSM method	20	L3	CO4	PO1,2
	UNIT - V	**20**			
5 a.	By quoting the uses of Monte Carlo method, explain briefly the various steps involved in this technique in estimating f_R (r). Also explain the procedure of generating a random derivative from a specific distribution. Hence explain inverse transformation technique.	20	L3	CO4	PO1,2
	OR				
5 b.	A simply supported beam of span 'l' with UDL 'w' with a circular cross section and uniform loading having a deflection of Δ. $$\Delta = \frac{5WL^4}{384EI}$$ Assume that l, E and W are deterministic variables. Also assume that the diameter is a random variable over the range $d_a \leq d \leq d_b$. Compute standard deviation and CoV of deflection using Monte Carlo method.	20	L3	CO4	PO1,2

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