(Ex/PG/CT/T/213A/2018)

MASTER OF CONSTRUCTION ENGG.3rd SEM.EXAM-2018
STRUCTURAL SAFETY, RELIABILITY & MAINTENANCE MANAGEMENT

Time : Three hours **Part -I** Full Marks : 100

Answer any **Three** Questions. Answer Maximum 50 marks

1. a) Discuss **different Limit states** in the context of **structural safety** analysis. (7)

   b) Discuss **performance function** and derive **probability of failure** in the context of **Structural Reliability**. (9)

2. a) What do you mean by **Reliability?** Discuss reduce variables and illustrate **Reliability index** (FORM) as defined by **Hasofer and Lind**? (7)

   A fixed beam is subjected to a concentrated live load P and a uniformly distributed dead load w. Assuming the length L is 7 m and the plastic section modulus Z is 1800 cm^3 are precisely known but loads **P, w, and the yield stress F_y are random variables**, calculate the **Reliability index (FORM)** with the following data. The Bias factor, which is defined as the ratio of the mean value of a variable to its nominal value (denoted by λ) is specified for each of the random variables. The distribution parameters of P, w, & F_y are as follows.

   Nominal (design) value of $w = w_n = 30$ kN/m

   Bias facto for $w = \lambda_w = 1.2$, Co-efficient of Variation COV $V_w = 6\%$

   Nominal (design) value of $P = P_n = 200$ kN

   Bias factor for $P = \lambda_p = 1.2$, COV $V_p = 4\%$

   Nominal (design) value of $F_y = f_y = 450$ MPa

   Bias factor for $F_y = \lambda_F = 0.87$, COV $V_F = 5\%$

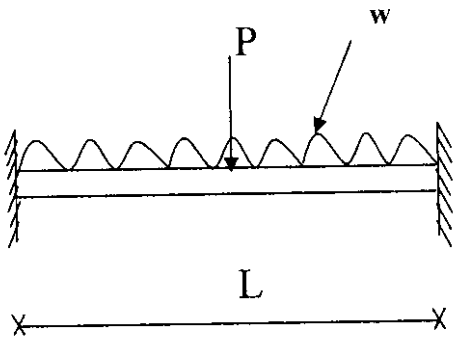

Fig 1: Fixed Beam

(10)

3. a) Discuss **Total Probability theorem and Bay's** theorem. (4)

b) Delay (D) in a construction project can be caused by material shortage (M), labor trouble (L), and bad weather (W); the corresponding probabilities are 40%, 40%, and 20%, respectively. Assume M, L, and W are mutually exclusive and collectively exhaustive, and the likelihood of their occurrence is 2:2:1, respectively.

i) What is the probability of delay of the construction project? (3)

ii) If the project was delayed, what is the probability that the delay was caused by bad weather? (3)

c) A **pre-stressed concrete** beam can fail due to either excessive bending moment (M) ,excessive shear (S) force of on concrete or Tension of Pre-stressing steel (T). It is observed that the failures of beam are occurred 65% due to moment, 5% due to shear and 30% due to tension of pre-stressing steel. It is also observed that small diagonal crakes (C) occur in 80% cases of shear failure & 10% cases of moment & tensile failure. If some diagonal crakes are noticed during inspection, calculate the probabilities of occurrences of excessive shear and excessive moment of concrete and tension of pre-stressing steel? (7)

4. a) Discuss **De Morgan's Rule** with example (7)

b) At a particular location, the probabilities of occurrence of **cyclone** and **moderate earthquake** in single minute are $\mathbf{10^{-5}}$ **and** $\mathbf{10^{-8}}$ respectively. Assuming their events are statistically independent, calculate the probability of no earthquake in a year and in 50 years life of structure. Evaluate the probability of cyclone in 50 years life of structure. Also evaluate the probability of joint occurrence of cyclone & earthquake simultaneously? (9)

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Part -II

Answer any ***three*** of the following : Answer Maximum 50 marks

1) Derive Safety Index or Reliability Index considering Load and Resistance as normal and log -normal variables. (Derive only for single load case.) (16)

2) To avoid using very irregular earthquake load time histories, equivalent uniform cyclic loading N_{eq}, can be considered, specifically in geotechnical earthquake engineering. Fifteen such recorded earthquake time histories are considered and corresponding N_{eq} values are calculated. The magnitude of the earthquake on Richter scale m and the corresponding N_{eq} values are as follows:

M	5.2	5.4	5.6	5.8	6.0	6.2	6.3	6.4
N_{eq}	5.6	5.7	5.8	5.9	6.5	6.9	7.5	8.5
M	6.6	6.8	7.0	7.2	7.5	7.9	8.0	
N_{eq}	9.0	11.0	13.2	14.5	18.0	24.0	26.0	

Develop regression equation of considering $N_{eq}=b_0+b1M$ and $N_{eq}=b_0+b1M+b2M^2$. (17)

3) The Joint function of two random variable X and Y can be represented as (17)

$f_{X,Y}(x,y) = ce^{x+y}$ Where $0 \le x \le 1$ and $0 \le y \le 2$.

$= 0$ elsewhere

i) Determine the constant c.
ii) Determine the marginal density function of X.
iii) Determine the marginal Density function of Y.
iv) Are X and Y statistically independent?

4) The test data for Modulus of Elasticity (E) of a Bridge are shown below. Compute the Sample Mean, Standard Deviation, Coefficient of Variation, Skewness and kurtosis.

Test No.	Modulus of Elasticity E (ksi)	Test No	Modulus of Elasticity E (ksi)
1	28,900	06	25,900
2	29,200	07	32,000
3	27,400	08	33,400
4	28,700	09	30,600
5	28,400	10	32,700

Calculate the Mean, Variance, Standard Deviation, Coefficient of Variation and Skewness for the Modulus of Elasticity.

(16)