MASTER OF CONSTRUCTION ENGG.3rd SEM.EXAM-2024
STRUCTURAL SAFETY, RELIABILITY & MAINTENANCE MANAGEMENT

Time : 3 Hours **Full Marks: 100**

Answer any **Four** Questions. Discuss to the point with neat sketches if require

1. a) What is the significance of **Structural Reliability**. How it is related to the Probability of Failure? **(5)**

b) Discuss the need for reliability evaluation and **measure of reliability**. **(6)**

c) What are the different sources of **uncertainty** ? Discuss with examples **(6)**

d) Discuss the steps in **modeling** of non-cognitive uncertainty with flow chart **(8)**

2. a) Discuss in detail the **different Limit states** to be considered in **structural safety** and **Reliability analysis**. **(13)**

b) Discuss **Performance function** in the context of **Load & Resistance** and Probability of Failure. **(12)**

3. A fixed beam is subjected to a **concentrated live load P and a uniformly distributed dead load w.** Assuming the span length **L (6 m)** and the plastic **section modulus Z (1500 cm^3) are precisely known** but loads **P, w and the yield stress F_y** are **random variables**, calculate the **Reliability index** with the following data. **(25)**

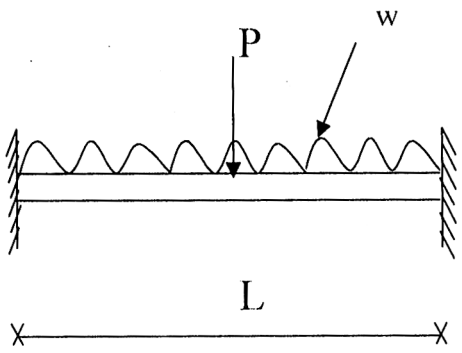

Fig 1: Fixed Beam

The distribution parameters for P, w and F_y are given below.

Mean (design) value of **w = 37.5 kN/m**

Co-efficient of Variation **V_w = 8 %**

Mean (design) value of **P = 140 kN**

Co-efficient of Variation **V_p = 11%**

Mean (design) value of **F_y = 285 MPa**

Co-efficient of Variation **V_F = 4 %**

4. a) Discuss **Bay's theorem** in the context of the theorem of **Total probability** with example in **Venn diagram**. Discuss **De Morgan's Rule** **(8)**

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 35%, 50%, and 15%, respectively. Assume M, L, and W are mutually exclusive and collectively exhaustive, and the likelihood of their occurrence is **3:2:1, 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 **building can be damaged** due to natural disaster of **Fire(F), Cyclone (W), Earthquake (E),** which are collectively exhaustive and mutually independent. If the probabilities of damage due to **F, W & E are 0.01, 0.02 and 0.1** and the occurrence of **F, W & E are 0.55, 0.35 and 0.1** respectively, then

i) What is the probability of damage due to natural disaster in **building's life**? **(3)**

ii) If the **building got damaged** then what are the **probabilities that the cause is due to F, W and E?** **(3)**

d) A **reinforced concrete beam** can fail due to either excessive **bending moment (M)** or **excessive shear (S) force** with failure modes in ductile and brittle respectively. It is observed that the failures of beam are occurred **75% due** to moment and **25% due to shear**. It is also observed that small **diagonal crakes (C)** occur in **95% cases of shear failure & 5% cases of moment** failure. If some diagonal crakes are noticed during inspection, calculate the probabilities of occurrences of **excessive shear and excessive moment**? **(5)**

5. a) Discuss the Space of State Variables in the context of Structural Safety **(8)**

b) What do you mean by Reduced variables and discuss its significance? **(5)**

c) Define **Reliability Index** as defined by **Hasofer** and **Lind.** Illustrate **First Order Second Moment** (FORM) of Reliability Index **(12)**