B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure. Credit=4**			**Pre-Requisite**
CE 413: Vulnerability and Risk Management	**L**	**T**	**P**	**Nil**
	3	**0**	**2**	

Course Objective: To impart knowledge and skill involving basic concepts and processes required for vulnerability and risk assessment and management to infrastructures due to different hazards.

S. No	Course Outcomes (CO)
CO1	Introduction to the various hazards encountered for civil infrastructure.
CO2	Introduction to randomness associated with hazards and probability.
CO3	Proficiency for modelling random variables for the design of structures.
CO4	Proficiency for the vulnerability assessment including **d**amage statistics and cumulative damage models.
CO5	Students are able to implement knowledge for risk assessment and management in civil infrastructures.

S. No	Contents	Contact hours
UNIT 1	**Introduction:** Overall view of Hazard, Vulnerability, and Risk assessments for Natural Hazards, Risk, terminology, randomness, uncertainty, Sources of Uncertainty, Steps in the Modelling of Uncertainty. Modelling of Uncertainty: Descriptors of Randomness.	8
UNIT 2	**Basics of Probability:** Sample space and events, Interpretation of probability, Probability axioms, Elementary theorems, conditional probability, Bayes' theorem. Random Variables: Definition of random variables - discrete and continuous; Probability definitions - PMF, PDF, CDF; Moments and expectations. **Probability Distributions:** Discrete distributions - binomial distribution, Poisson's distribution; Continuous distributions – uniform distribution, exponential distribution, gamma distribution, Weibull, Normal, and lognormal distributions. Extreme value distributions, Multivariate Distribution-Bivariate Normal distribution, other bivariate distributions, Transformations to Normal distribution	10
UNIT 3	**Determination of Distributions a Parameters from Observed Data:** Determination of Probability Distribution, Estimation of Parameters of a Distribution, Interval estimation of Mean and Variance, Tests of goodness-of-fit	8

	(chi-square test, Kolmogorov-Smirnov test), Modelling random variables like loads, material properties etc.	
UNIT 4	**Vulnerability Assessment:** Damage statistics and cumulative damage models, analytical and hybrid methods, calibration of models. Simulation Methods: Basis of simulations methods, random number generation, concept of Monte Carlo simulation and applications, Case study of Monte Carlo simulation.	8
UNIT 5	**Risk Assessment and Management:** Risk assessment due to various types of structures, Probabilistic and deterministic risk analysis**,** Probabilistic risk assessment application to Civil engineering problems using MATLAB	10
	Total	**42**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Haldar, A., and Mahadevan, S. "Probability, reliability and statistical methods in engineering design." John Wiley and Sons, New York.	1999
2	J R Benjamin and C A Cornell, "Probability, statistics and decisions for civil engineers," John Wiley, New York.	1976
3	A Papoulis, "Probability, random variables and stochastic processes" 3rd Edition, McGraw-Hill, New York.	1991
4	HAZUS-MH, MR1& MR2 Technical Manual, Federal Emergency Management Agency	2020