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JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2026

B.Tech-VIII Semester

COURSE CODE (CREDITS): 21B1WCE831 (3) MAX. MARKS: 60

COURSE NAME: DISASTER RISK ANALYSIS AND MANAGEMENT

COURSE INSTRUCTORS: DR. SAURAV MAX. TIME: 2 Hours

Note: *(a) All questions are compulsory.*

(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

(c) Use of Non programmable calculator is allowed.

Q.No	Question	CO	Marks
Q1	A coastal Indian state frequently faces floods and cyclones causing severe economic and infrastructure losses. After a recent disaster, the government decided to adopt a resilience-based disaster management strategy aligned with the Sendai Framework (SFDRR 2015 2030) and NDMP 2016. Proposed measures include hazard mapping, early warning systems, resilient infrastructure, and community preparedness. As a Disaster Risk Analyst, a) Explain the concept of Disaster Risk Assessment (DRA) and analyze the shift in disaster management philosophy from response-based approaches to prevention and resilience-based approaches. b) Discuss the relevance of SFDRR and its alignment with India's DM Act 2005 and NDMP 2016, and evaluate how engineering, policy, and governance interventions can improve long-term disaster resilience and sustainable risk reduction.	2	10
Q2	A highway bridge is to be designed such that the probability of failure due to extreme flooding during its 50-year design life does not exceed 2%. Determine the required return period of the design flood to be adopted for the bridge design.	2	4
Q3.	Annual maximum flood data of the Brahmaputra River at a bridge site for the period 1985 2020 shows a mean annual flood discharge of 31,500 m^3/s and a standard deviation of 1,950 m^3/s. A new highway bridge is proposed across the river. The acceptable risk of exceedance during the expected design life of 75 years is fixed at 5%. Given: $N = 36$ years, $y_n = 0.540$, $S_n = 1.160$ **a)** Using Gumbel's distribution, estimate the design flood discharge for the bridge. **b)** If the actual flood discharge adopted in the bridge design is 125,000 m^3/s, determine the safety factor and safety margin for the structure.	3	10
Q4.	A transportation tunnel located in a mountainous seismic region may become inoperable due to earthquake and landslide hazards. The failure of the tunnel system (Top Event) occurs under the following conditions: 1. The tunnel fails if strong earthquake shaking **(A)** occurs together with structural lining failure **(B)**. 2. Structural lining failure **(B)** occurs if either: o Poor construction quality **(C)**, or o Excessive internal stress **(D)** caused by ground movement. 3. Excessive internal stress **(D)** occurs when both: o Ground displacement **(E)** and o Water seepage into the tunnel lining **(F)** occur simultaneously. 4. The tunnel may also fail if a major landslide blocks the tunnel portal **(G)** independently.	3	10

The probabilities of the basic events are given below:

Event	Description	Probability
A	Strong earthquake shaking	0.03
C	Poor construction quality	0.02
E	Ground displacement	0.015
F	Water seepage	0.02
G	Major landslide blocking tunnel portal	0.01

Assume that all basic events are statistically independent.

a) Develop the Boolean expression for the top event in terms of the basic events.

b) Determine the minimal cut sets for the system.

c) Calculate the probability of each minimal cut set.

d) Estimate the top event probability using the minimal cut set approximation method.

e) Identify the most critical failure path contributing to tunnel failure.

Q5. A coastal industrial city is vulnerable to two independent hazards: Annual probability of severe cyclone: $p_c = 0.004$ and Annual probability of major storm surge flooding: $p_s = 0.005$. Assume that the occurrence of hazards is independent both within a year and across different years. 3 6

a) Calculate the annual probability that the city experiences at least one hazard event.

b) Analyze the long-term safety of the city by determining the probability that no hazard occurs during the next 40 years.

c) Interpret the significance of the obtained probability values for disaster preparedness and infrastructure planning.

Q6. A mountainous region experienced severe landslides and flash floods after continuous rainfall. The disaster management authority used satellite imagery, drones, and GIS-based spatial analysis to identify affected areas, monitor damaged infrastructure, and plan evacuation routes for nearby villages. 4 10

(a) Explain the concepts of Remote Sensing and Geographic Information Systems (GIS) in the context of disaster management.

(b) Analyze the role of Remote Sensing and GIS in hazard identification, damage assessment, emergency response, and disaster mitigation planning.

(c) Discuss the advantages and limitations of Remote Sensing and GIS for effective disaster risk management.

Q7. A coastal flood protection system is exposed to multiple failure mechanisms. The city is considered flooded (Top Event **T**) under the following conditions: 4 10

- The sea wall fails during a severe cyclone (Event A), and this leads to failure of the drainage system.

- The drainage system fails if either:
  - there is pump malfunction (Event B), OR
  - there is complete power failure, which occurs only when both:
    - grid failure (Event E) and
    - backup generator failure (Event F) occur simultaneously.
- Additionally, the city may flood independently due to an extreme storm surge overtopping all barriers (Event G).

Data: P(A)=0.12, P(B)=0.09, P(E)=0.07, P(F)=0.10, P(G)=0.04

Random Numbers for 10 Monte Carlo Trials

Trial	A	B	E	F	G
1	09	05	04	08	55
2	14	12	02	07	03
3	07	15	11	06	80
4	18	04	05	09	02
5	03	22	08	15	10
6	11	07	03	05	66
7	05	02	01	04	01
8	20	18	12	07	50
9	08	06	02	03	04
10	16	09	05	11	70

a) Formulate the Boolean expression for the top event T.

b) Reduce the expression to basic events only.

c) Determine the minimal cut sets of the system.

d) Perform Monte Carlo simulation using the given random number table.

e) Estimate the probability of system failure.