

Syllabus for Ph.D. Entrance Exam for Disaster Assessment and Mitigation (DAM)

Hazard, Vulnerability and Risk Assessment

Introduction to Hazard: Definition of hazard, Hazard estimation, Effect of hazard on structures.

Vulnerability: Definition of vulnerability, Methodologies of vulnerability assessment, Evaluation, Building Types, Micro & Macro methods, Intensity Scales, Damage probability matrix, Vulnerability functions.

Risk: Definition and components of risk, Fundamentals of risk analysis, Element at risk and their attributes, Seismic risk evaluation, Assessment for different disasters, Extreme event analysis.

Disaster: Direct and indirect damages, Ground failures in the past earthquake, Damage to structures, Associated damage due to fire, flooding and tsunami, Failure of embankments, dams and bridges.

Disaster Mitigation: The collection of data and information, Quantified risk assessment for industrial accidents; Release of toxic products, Dispersion analysis.

Natural and Manmade Disasters

Introduction to natural resources, Distribution of natural resources, Challenges, Natural disasters and their classification, Scales of disasters, Disaster Management Act and Policy, Institutional framework and mechanism, History and status of disaster management in India, Terminology and concepts in disaster risk management.

Earthquake Physics: Wave propagation, Wave types (compression, shear, surface), Attenuation; Causes: Tectonic plate motions, Magma movement, Isostatic rebound, subsurface fluid changes; Effects: No damage or massive damage, Tsunamis, Subsidence, Detection, Seismic network, Warning, Recovery; Updated building codes, Man mitigate damage. *Tsunamis Physics:* Pressure, Wave propagation, Causes: Earthquakes, Underwater landslides; Effects: Sudden rise and fall in sea level, Coastal damage, Loss-of-life; Detection: Seismic networks, Pressure gauges, Wave-height buoys, Warning, Siren, Recovery: Hampered by loss of infrastructure; Rebuild with knowledge that it can happen again, Upgrade facilities and infrastructure. *Volcanic Eruptions Physics:* Pressure, Density, Causes: Tectonic plate interactions, Hot spots; Effects: Lahars (hot mud flows), Nue Ardente (fiery clouds), Lava flows over roads and buildings, Ash flows, Earthquakes, Detection: Small seismic network, Tilt meters, Laser ranging. *Landslides Physics:* Friction, Causes: Saturated soil, Unstable snow; Effects, Detection: Geologic profiles identify candidate areas, Snow depth, cohesion, etc. *Floods Physics:* Response time, Fluid flow, Causes, Excessive rain upstream, Channelizing Effects: Property loss, Life loss, Sedimentation, Change in course of river, Detection: Stream gauges, Forecast models of stream flow; Recovery: Move people & buildings, Build dykes, Flood control. *Nuclear accidents (TMI and Chernoble) Physics:* Nuclear energy, Half-life, Causes: Operational mistakes, Poor construction, Poor design; Effects: Radioactive fallout, Radiation sickness, Increased cancer rate, Detection: Radiation monitors, Radionuclide observations; Recovery: Clean-up & disposal of contaminated

material, Iodine tablets. *Droughts*: Classification of droughts, Causes of droughts, Effects of droughts, Preventive measures of droughts, Drought management strategies.

Spatial Data Collection and Analysis

Basics of map reading, Types and sources of map, Cartographic representation of data, Map coordinate system, Projections and their types, Guidelines for preparing a base map, Thematic mapping.

Aerial photographs, Mosaic, Image interpretation - Elements and methods, Stereo-model.

Physics of remote sensing: Electromagnetic spectrum and spectral signatures, Types of remote sensing, Platforms and sensors, Active and passive sensors, Aerial photographs, Satellite images, Radars, Sensor characteristics, Resolution - spatial, spectral, radiometric and temporal, Image interpretation - Elements and methods, Image correction - Geometric, Digital image enhancement techniques (stretching, filtering), Classification: supervised and unsupervised, Application of remote sensing techniques in resource and environment mapping, Monitoring case studies.

Introduction to Microwave Remote Sensing.

Global Positioning Systems (GPS): Introduction to the GPS functions, Field operation of GPS and data collection using GPS, Basic concepts and components of GIS.

Climate Variability and Adaptation

Climate Change Policy Framework: Climate change as a problem, Impacts of climate change, Climate variability and natural resources, United Nations Framework Convention on Climate Change (UNFCCC), Background to the Convention and its aims, Kyoto Protocol and the Flexibility Mechanisms, Emission trading.

Mitigation: Mitigation and policy evaluation, Strategies and technology options, Climate change case studies.

Adaptation: Adaptation and policy evaluation, Strategies and technology options, Case studies of adaptation, Evaluation of the effectiveness of approaches in managing climate change risk, Effectiveness of policy approaches in reducing climate change and variability risk.

Geoinformatics and Its Applications

Geographical Information System: Components of GIS; Feature types, Spatial data models (raster & vector) - their advantages and disadvantages; Spatial data creation and management- methods, topology creation, editing and manipulation, attaching attribute data.

Spatial analysis: Single and multiple layer spatial analysis, Spatial querying; arithmetic and logical operations, 3D analysis, Spatial data visualization - map design and layout for thematic layers and display of tables and graphs using GIS software, Application of GIS in natural resources assessment and inventory, Change detection, Applications of GIS for assessment of disasters, Preparation of vulnerability maps for different type of disasters, Prioritization analysis for mitigation of different types of disasters.

Rehabilitation, Reconstruction and Recovery

Recovery and reconstruction: Introduction, Medium and long term recovery aspects, Community participation in defining objectives and their priorities, Disaster risk communication.

Rehabilitation: Physical and social infrastructure, Relocation and reconstruction of housing, public buildings, bridges, dams, archives and monuments, services such as water supply, electricity, waste management, communication, capacity building for self-help construction, Numerical condition surveys for foundation, Structural and functional deterioration, Design criteria, Materials and techniques. Predictive performance models, Repair and retrofitting: Earthquake damages of buildings, their retrofitting and restoration, Superficial repair, Structural repair, Structural strengthening of habitable spaces, public buildings, roads, bridges, dams, culverts etc.

Disaster Resilient Structures and Retrofitting

Earthquake effects on the structures, Classification of loads, Seismic methods of analysis, Seismic design methods, Seismic damages during past earthquakes and effect of irregularities and building architecture on the performance of structures, Basic design considerations for multistoried RC and steel structure with foundation as per latest IS:1893, Capacity based design of building, Types of ductility, Factors affecting ductility, Ductile detailing as per latest IS:13920, Seismic design considerations for masonry buildings.

Fire safety of buildings, Effect of high temperatures on different types of steel and concrete structural members, Fire resistance by structural detailing, Analytical determination of the ultimate bending moment, Design of RC members for fire resistance, Introduction of IS:1642.

General characteristics of blast and effects on structures, Blast load on above and below ground structures, Response of structural elements to blast force, Dynamic strength of materials and design stresses, Load combinations for design, Introduction of IS:4991.

Sources of weakness in RC and Steel framed buildings, Classification of retrofitting techniques, Conventional and non-conventional methods, IS code provisions for retrofitting of masonry structures.

Disaster Response and Preparedness

Global Disaster: Global and Indian scenario, Science and policy, Institutional framework for disaster preparedness and mitigation, Managing natural and anthropogenic disasters, Principles and practice of disaster response operations and management, Disaster Planning, Public Administration/Policy and Emergency management, Incident command center, Training need analysis and human resource development plan, Corporate/public agency coordination, Human element in preparedness planning, Current trends in disaster preparedness. Hazard monitoring, tracking and modelling, Early warning systems, Warning protocols, Indian disaster resource network, Public health aspects of disaster management and emergency services systems, Urban hazards and disaster planning, Fire services preparedness, Emergency sanitation, Shelter environments, Conceptual and Applied Issues in Emergency Management: Operational decision making, Introduction to emergency management and planning, Organization and structure of emergency management, Emergency management research methods and analysis, Public information for emergency

management, Principles and practice of disaster relief and recovery, Logistic support system, Computer applications in emergency management. Principles of natural hazard reduction, Toxicology and biohazards in emergency management, Terrorism Preparedness: Critical infrastructure and emergency management, Emergency preparedness, response, and planning for hazardous materials, Terrorism, WMD and other contemporary issues, Incident management systems and emergency operations center, Contingency planning, Community emergency response team, Community relations for environmental and emergency managers, Contingency planning for business and industry, International disasters.

Disasters and Special Structures

Introduction to Special Structures and Their Uses: Bridges, Dams, Nuclear power plants, Thermal power plants.

Underground Structures: Tunnels, Subways and Storage Tanks, Pipelines, Railways, Roads, Retaining structures, Liquid storage tanks, Waterways, Reservoirs, Wastewater infrastructure and Offshore structures.

Performance of special structures during past disaster, Vulnerability of special structures, Health monitoring, Operations and maintenance, Potential threats and risk assessments, National and international policies, Environmental impact due to damage of special structures, Case study, Emergency plan and risk reduction, Post-Disaster recovery and reconstruction.

Geohazards and Mitigation Measures

Sudden Geologic Hazards: Earthquakes, Tsunamis, Liquefaction, Volcanic eruptions, Pyroclastic flows and Ash falls, Landslides and Avalanches, Rock falls and Debris flow, Glacial bursts, Flash floods, Geomagnetic storms.

Gradual Geologic Hazards: Geogenic groundwater contamination (arsenic, fluoride, etc.), Stream erosion, Coastal erosion, Alluvial fans, Salt water intrusion, Ground settlement, Ground subsidence and sink holes, Sand dune migration and desertification.

Mitigation Measures: Geosynthetics in hazard prevention and containment, Hazard warning systems, Engineering and construction measures in hazard mitigation, Adaptive urban planning in hazard mitigation.

Hydrometeorological Disasters, Adaptation and Mitigation

Hydrologic cycle, Relationship between hydrology, meteorology and climatology, Hydrometeorology, Importance of study of hydrometeorology, Hydrometeorological extreme events, Characteristics of extreme events, Climate change impacts on hydrometeorology, Hydrometeorological hazards and disasters, Flood, Drought, Storms and Heat & Cold Waves, Causes, effects and their impacts, Hydrometeorological hazard monitoring and forecasting, Early warning systems, Risk assessment and Socioeconomic responses, Resilience of communities to hydrometeorological hazards, Adaptation and Mitigation measures and considerations, Hydrometeorological hazard studies, their mapping and impact assessment.

Introduction to Sustainable Development

Introduction: Definitions of Sustainable development, Pillars, Principles, Evolution and parameters of sustainable development, Issues and challenges to sustainable development, MDGs, SDGs.

Tools for Sustainability: Environment management, Environmental legislations, ISO 14000, Life cycle assessment, Environmental impact assessment case studies,

Sustainable Engineering: Overview of Sustainable Engineering, Case studies in sustainable engineering, Sustainable waste water treatment, Solid waste, Sanitation practices/ methods, Nexus between technology and sustainable development, Financial sustainability.

Innovative Practices: Applications of sustainability, Sustainable development in urban system, Water conservation, Sustainable transport systems, Sustainable habitats.

Lifeline Services and Disasters

Water and Sanitation: Availability and supply of water, Water quality, Disinfection of water sources, Rehabilitating water distribution systems, Emergency treatment of drinking-water, Cleaning wells after seawater flooding, Hygiene promotion in emergencies, Measuring chlorine levels in water supplies, Planning for excreta disposal in emergencies, Technical options for excreta disposal in emergencies.

Power Sector: Generation, Transmission and Distribution System, Grid disturbance and disasters, Blackout, Causes of disaster in Power Sector, Major areas prone to disaster, Power system restoration, System Security, Safety of equipment for disasters, Hazardous and toxic materials and their management in power sector, Cyber Threats, Cyber security for Power Grid, Disaster Management in power sector.

Transportation System: Transport Infrastructure Systems, Interdependencies, Vulnerable systems, Potential threats and risks, Transportation disruption, Transportation disaster planning, Risk assessment, Preparedness, Mitigation, Response, Recovery, Transportation Resilience, Monitoring and assessment, Emergency response and risk reduction, Pre-disaster risk assessment and management, Policies, Institutions, and Processes, Technical-planning, operations and maintenance, Post-Disaster recovery and reconstruction.

Socio-Economics of Disasters and Disaster Finance

Disasters and the macro-economy, Public finance and disasters, Funding for Disaster Management – State Disaster Mitigation fund, State Disaster response fund (SDRF), National Disaster Response Fund (NDRF), Prime Minister National Relief Fund (PMNRF), Chief Minister Relief Fund and Role, Financing the cost of future disasters.

Information on Natural Hazards and Disaster Reduction, Financial management of disaster risks, Assessment of disaster risks, Financial vulnerabilities and the impact of disasters.

Insurance Policies for Disaster Management: Evaluation of risk funding and risk transfer policies, Catastrophe insurance pool, Reserve funds and contingent credit policies, Role of Government and market participants, Insurance policy design, Fiscal cost of relief and reconstruction, Grants and low interest loan for reconstruction.

Legal Considerations for Disaster Financial Management.