INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Earthquake Engineering

Subject Code: EQN- **Course Title:** Seismological Modelling and Simulation

L-T-P: 3-0-2 **Credits:** 4 **Subject Area:** PCC

Course Outlines:

Introductory plate tectonics; earthquake recording; earthquake magnitude and intensity scales; theory of elasticity; elastodynamic wave equations; laws governing seismic wave propagation and attenuation; factors affecting SGM characteristics; finite-difference (FD) modelling – spatial and temporal discretization, free surface and absorbing boundary conditions; point source and finite source implementation; kinematic and dynamic rupture simulation; stochastic point-source and finite-source models; basic signal processing.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Earthquake Engineering

Subject Code: EQN- **Course Title:** Seismic Hazard Assessment

L-T-P: 2-1-0 **Credits:** 3 **Subject Area:** PCC

Course Outlines:

Introductory seismic hazard, risk and vulnerability, cases, seismicity data, seismicity catalogues and statistical analyses; earthquake sources, earthquake occurrence models (ETAS, EEPAS); time and slip predictable earthquake forecasting, Gutenberg-Richter and Gumbel models; ground motion prediction, elastic and inelastic response spectra, displacement spectra, deterministic and probabilistic seismic hazard analysis, logic-tree and bed-rock level hazard estimation, exceedance probability, return periods; earthquake simulations.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Earthquake Engineering

Subject Code: EQN- **Course Title:** Structural Dynamics

L-T-P: 3-0-2 **Credits:** 4 **Subject Area:** PCC

Course Outlines:

Dynamic equilibrium and mathematical models; dissipation mechanisms; Undamped and damped, free and forced vibrations; Steady-state and transient response, impulse response; Harmonic response and applications to vibration isolation; Seismometers, accelerometers; Convolution integral; Numerical methods for time marching; response/shock spectra; Fourier transforms and frequency domain; Lagrange's equations; MDOF systems; Algebraic eigenvalue problem and free vibration analysis; Undamped and damped normal modes; Mode superposition method; Mode-truncation and correction for the missing mass; Hamilton's principle; Axial and transverse vibrations of beams, torsional vibrations of shafts; Vibrations of elastic half-space.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Earthquake Engineering

Subject Code: EQN- **Course Title:** Seismic Vulnerability and Risk Analysis

L-T-P: 3-0-2 **Credits:** 4 **Subject Area:** PCC

Course Outlines:

Components of seismic risk – hazard, vulnerability and exposure; assessment of vulnerability via empirical, analytical, experimental and hybrid approaches; use of intensity scales; capacity spectrum method; HAZUS methodology; displacement-based approach; approaches for assessment of exposure quantification of risk, loss ratios, and indoor and outdoor casualty rates; case studies (e.g., RADIUS, HAZUS, PAGER, GEM, EU-RISK); earthquake damage surveys; classification of damage; estimation of fragility from damage data; risk communication

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Earthquake Engineering

Subject Code: EQX-XXX **Course Title**: Mechanics of Deformable Media

L-T-P: 3-1-0 **Credits**:04 **Subject Area**: PEC

Course Outlines:

Continuum description of deformable solids. Tensor algebra and calculus. Kinematics, displacement gradients, and strain relations. Conservation laws, linear elastic constitutive laws, and elastoodynamic wave equations. Other constitutive laws encompassing strain rate dependency, visco-elasticity; linear elastic fracture mechanics, introductory treatment of porous media; elastic stability, buckling, fatigue, corrosion, and crack extension under cyclic loads.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Earthquake Engineering

Subject Code: EQN- **Course Title: Seismic Microzonation**

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines:

Historical development of seismic microzonation; multi-disciplinary data requirements; seismic zoning of India; scales, grades and major steps involved in seismic microzonation; site characterization using geophysical and geotechnical methods; 1D soil/basin amplification, resonance, trapping; 2D and 3D basin effects, surface wave generation and basement focusing; site-city-interaction (SCI) effects on free-field motion and building response; surface topography effects; microzonation deliverables; case studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Earthquake Engineering

Subject Code: EQN- **Course Title: Earthquake Precursors and Early Warning Systems**

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines:

Precursor definition, scope and its relation with earthquake prediction, forecast and warning; types of precursors; precursor's relation to main event; physical phenomenon associated with precursors; case studies; earthquake precursor models; seismic gaps for large earthquakes; concept of earthquake early warning (EEW) systems; onsite and regional EEW; description of some world-wide EEW systems; requirements of EEW system; algorithms for EEW systems; advantages and limitations of EEW systems.

Indian Institute of Technology Roorkee

NAME OF DEPARTMENT: **Departments of Earthquake Engineering**

Subject Code: EQN-539 **Course Title**: Physics of Earthquakes

L-T-P: 3-1-0 **Credits**:04 **Subject Area**: PEC

Course Outlines:

Fracture models of faults, tectonic loading, stress drop, interfacial strength, rate- and state-dependence, fault slip evolution, slip instabilities, stick-slip, critical fault size, critical stiffness, LEFM basics, strain energy release rate, fracture energy and toughness, breakdown energy, rupture propagation condition, crack tip singularity, cohesive zone, dynamic rupture, seismic cycle, induced seismicity.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Earthquake Engineering

Subject Code: EQN- **Course Title: Geoinformatics**

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines:

Deformation, Stress, Strains, lithospheric plates, earthquakes and tectonics, earthquakes in different geological set ups, geotectonic implication; remote sensing in earthquake geology, mapping, GIS in earthquake geology.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Earthquake Engineering

Subject Code: EQN- **Course Title: Risk Management and Insurance**

L-T-P: 3-1-0 **Credits:** 4 **Subject Area:** PEC

Course Outlines:

Introduction to risk; financial risk; objectives of risk management; ways to manage risk – risk avoidance, risk reduction, risk financing and risk transfer (insurance); insurance – definition and types; insurance as an institution, operations and management via regulations/actuarial laws; insurance laws and regulations in India; insurance as a product with special focus on infrastructure, case studies from earthquake engineering; risk to insurers.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Earthquake Engineering

Subject Code: EQX-XXX **Course Title**: Dynamical Systems with Machine Learning

L-T-P: 3-1-0 **Credits**:03 **Subject Area**: STAR

Course Outlines:

Dynamical systems, equilibrium and fixed-points, linearization, stability of fixed-point solutions, Lyapunov stability, asymptotic stability, problem parameter, bifurcations, types of bifurcations, normal forms; canonical PDEs as dynamical systems, SVD, Fourier modes vs. singular modes; dynamic mode decomposition, dynamics-identification algorithms; neural networks, physics informed machine learning; optimization, gradient descent, momentum gradient descent, ADAM, quasi-Newton's method and BFGS.