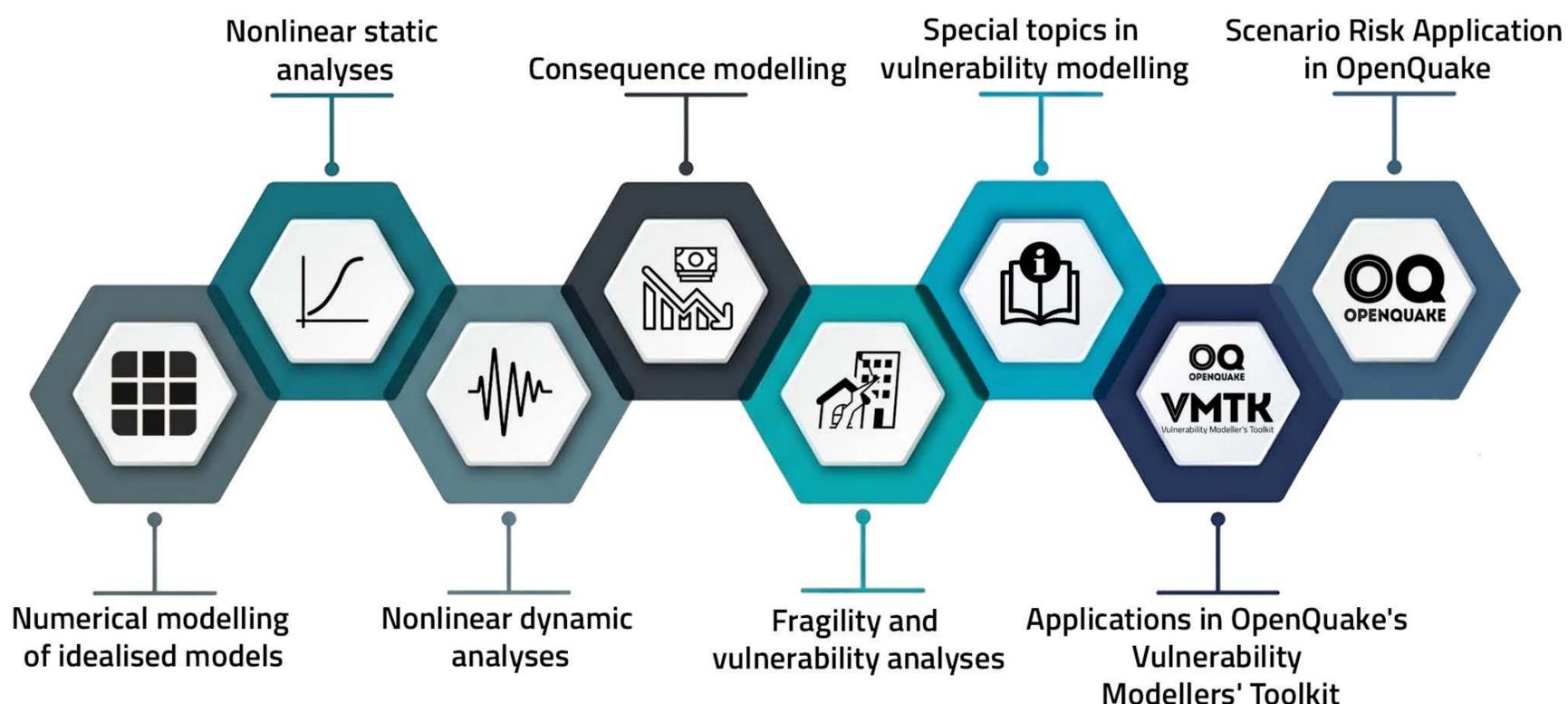# GEM MODELS AND OPENQUAKE ENGINE TRAINING:
Vulnerability Modelling

20th – 31st July 2026 | In person at EUCENTRE Foundation, Pavia, Italy

This course, offered within the Doctoral Programme in Earthquake Engineering at IUSS Pavia and organised by the Global Earthquake Model (GEM) Foundation, is designed to present an in-depth introduction to the latest methods and models for assessing seismic vulnerability, along with their development in the OpenQuake Vulnerability Modeller's Toolkit and their application in the OpenQuake Engine across a range of practical scenarios. The programme combines theoretical lectures with hands-on training sessions focused on the use of the OpenQuake Vulnerability Modeller's Toolkit, culminating in a case study implemented in the OpenQuake Engine.

KEY TOPICS

- Nonlinear static analyses
- Consequence modelling
- Special topics in vulnerability modelling
- Scenario Risk Application in OpenQuake
- Numerical modelling of idealised models
- Nonlinear dynamic analyses
- Fragility and vulnerability analyses
- Applications in OpenQuake's Vulnerability Modellers' Toolkit

PREREQUISITES

As a prerequisite for the course, knowledge of **Python** and **OpenSeesPy** is encouraged, along with some experience in numerical modeling of nonlinear systems.

LECTURES/TUTORIALS

20th – 31st July 2026 (In person at EUCENTRE Foundation, Pavia, Italy)

Instructions for reaching the classroom and the GEM Secretariat (both hosted at the EUCENTRE Foundation) can be found here: https://www.globalquakemodel.org/contact-us

REGISTRATIONS

The course is open to IUSS PhD students and external participants, with priority given to IUSS PhD students. External applicants are invited to submit a short CV along with their contact details.

For registration and further information, please contact: **mouayed.nafeh@globalquakemodel.org**

INSTRUCTORS

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TEACHING ASSISTANT

Furkan Narlitepe,
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TIMETABLE

DAY	MON20TH	TUE21ST	WED22ND	THU23RD	FRI24TH	MON20TH	TUE21ST	WED22ND	THU23RD	FRI24TH
AM	–	3.5 HRS	3.5 HRS	3.5HRS	3.5HRS	3.5HRS	3.5HRS	3.5HRS	3HRS	1H30
PM	–	2 HRS	2 HRS	2HRS	3HRS	3HRS	3HRS	3HRS	2HRS	–

AGENDA

There are no lectures on this day. Meetings can be arranged for those who need additional support to install the OpenQuake Engine and the Vulnerability Modeller's Toolkit.

Tuesday, July 21st

9:00 - 12:30
- Introduction to Vulnerability Modelling
- Nonlinear Modelling: SDOF vs MDOF for Regional Assessment
- Nonlinear Static Procedures
- Static pushover analyses
- Cyclic pushover analyses

14:00 - 16:00
- Case Study Scenario Introduction
- Introduction to OQ-VMTK
- Model Compilation and Nonlinear Static Procedures in OQ-VMTK

Wednesday, July 22nd

9:00 - 12:30
- Nonlinear Dynamic Procedures
- Modified Cloud Analysis (MCA)
- Multiple Stripe Analysis (MSA)
- Incremental Dynamic Analysis (IDA)

14:00 - 16:00
- Running MCA, MSA, and IDA in OQ-VMTK

Thursday, July 23rd

9:00 - 12:30
- Fragility Analysis for MCA, MSA, and IDA using state-of-practice statistical methods

14:00 - 16:00
- Postprocessing Fragility Functions from MCA, MSA, and IDA in OQ-VMTK

Friday, July 24th

9:00 - 12:30
- Building-Level Vulnerability Analysis: Damage-to-loss ratios
- Building-Level Vulnerability Analysis: Evaluation of economic loss models due to damage to structural elements and building contents.
- Building-Level Vulnerability Analysis: Evaluation of human-centric loss models (i.e., fatalities)
- Vulnerability Analysis using Storey Loss Functions (SLFs): Evaluation of economic loss models due to damage to nonstructural components damage

14:00 - 16:00
- Structural Vulnerability Analysis using OQ-VMTK
- Generation of Storey Loss Functions for Nonstructural Components in OQ-VMTK
- Nonstructural Vulnerability Analysis using SLFs in OQ-VMTK

AGENDA

Week 2

Monday, July 27th

9:00 - 12:30
- Derivation of OpenQuake-Ready Vulnerability Models: End-to-end Vulnerability Modelling

14:00 - 17:00
- Derivation of OpenQuake-Ready Vulnerability Models: End-to-end Vulnerability Modelling

Tuesday, July 28th

9:00 - 12:30
- Derivation of OpenQuake-Ready Vulnerability Models: End-to-end Vulnerability Modelling

14:00 - 17:00
- Derivation of OpenQuake-Ready Vulnerability Models: End-to-end Vulnerability Modelling

Wednesday, July 29th

9:00 - 12:30
- Scenario Hazard Assessment in OpenQuake: Scenario Rupture Definition and Generation of Ground-Motion Fields for various Intensity Measures

14:00 - 17:00
- Scenario Damage and Loss Assessment in OpenQuake: Damage and Loss Statistics

Thursday, July 30th

9:00 - 12:00
- Recent Advances in Vulnerability Modelling: State-Dependent Models for Earthquake Sequence Risk Applications
- Beyond Economic Losses: Vulnerability Models for Earthquake-Based Environmental Impact Assessment

14:00 - 16:00
- Q&A/ Open Discussion (Optional Attendance)

Friday, July 31st

9:00 - 10:30
- Final Examination

EVALUATION

There will be a formal examination for the course. Participants will be assessed solely through this exam, which will test their understanding of the theoretical and practical material associated with the GEM vulnerability methodology, models and the OpenQuake Engine.