*Summer 2023 Training Course:*

# *Artificial Intelligence Applications in Structural Engineering*

## Week 2: **Basics of structural analysis and FEM modeling**

**Dr. Shady Salem**– Civil Engineering Department

# Content

Agenda

- Lecture 1:
  - What is structural modeling.
  - Creating 2D model on SAP2000.
  - Defining material properties.
  - Assigning sections and boundary conditions.
  - Assigning loads.
  - Linear VS non-linear analysis.
  - Types of nonlinearity:
    - Geometric (large deformations, large strains);
    - Material (plasticity, creep);
    - Boundary (contact);
  - Pushover analysis.

Tutorial 1:

- Truss example
- Multistorey frame example
- 3D multistorey frame
- Nonlinear multistorey frame

# Content

Agenda

- Lecture 2:
  - What is OpenSees.
  - Why OpenSees.
  - OpenSees modeling levels (element, section, fiber).
  - Analysis algorithms.

Tutorial 2:

- Truss example
- Multistorey frame example

# OpenSees

OpenSees: Open System of Earthquake Engineering Simulation

## Why OpenSees

- Open and free source.
- Advanced modeling capabilities specially for EQ (nonlinear behavior, base isolation, uncertainty analysis,….etc.).
- Easily linked with coding programs (Python, Matlab,…etc).
- Easily linked with PEER and NEES.

# OpenSees

- OPenSees download:

https://opensees.berkeley.edu/OpenSees/user/download.php

- Opensees wiki:
  https://opensees.berkeley.edu/wiki/index.php/Main_Page

- Opensees example:

https://opensees.berkeley.edu/wiki/index.php/Examples

- Opensees forum:

https://www.silviasbrainery.com/opensees-forum

# Content

Agenda

- Lecture 3:
  - Nonlinearity modeling in Opensees
    - Concentrated VS Distributed plasticity
  - Types of lateral analysis
  - Pushover and dynamic analysis on Opensees

Tutorial 3:

- Multistorey frame example