PGDFLP13: Simulation & Modelling Tools

Course Objective

To provide students with the theoretical foundation and practical skills required to use advanced simulation and modeling tools for engineering and architectural applications. The course emphasizes system modeling, software-based simulations, and real-world applications across various disciplines like civil, mechanical, electrical engineering, and architecture.

Module 1: Fundamentals of Simulation and Modelling

- Introduction to modeling and simulation concepts.
- Types of models: Physical, mathematical, and simulation models.
- Applications in architecture, civil, mechanical, and electrical engineering.
- System behavior and dynamic systems.
- Benefits and limitations of simulation.

Module 2: Mathematical Foundations

- Mathematical modeling techniques: Differential equations, algebraic equations.
- Continuous vs. discrete systems.
- Statistical methods in simulation: Probability distributions and random number generation.
- Numerical methods for simulation.

Module 3: Tools for Simulation and Modelling

A. Architectural and Civil Engineering Tools

- Energy simulation tools: eQuest, EnergyPlus, DesignBuilder.
- Structural analysis tools: ETABS, STAAD.Pro, SAP2000.
- Building Information Modeling (BIM): Revit, ArchiCAD, Navisworks.

B. Mechanical Engineering Tools

- CAD and CAE tools: SolidWorks, CATIA, ANSYS.
- Thermal and fluid flow simulations: FLUENT, COMSOL Multiphysics.
- Kinematics and dynamics simulation: MATLAB/Simulink, Adams.

C. Electrical Engineering Tools

- Circuit simulation tools: PSpice, LTspice, MATLAB Simulink.
- Power systems modeling: ETAP, DIgSILENTPowerFactory.

- Electromagnetic simulation: CST, HFSS.

Module 4: System Dynamics and Process Simulation

- Introduction to system dynamics: Feedback loops and causal diagrams.
- Process simulation tools for industries: Aspen Plus, HYSYS.
- Case studies in process optimization and manufacturing.

Module 5: Virtual Reality (VR) and Augmented Reality (AR) in Simulation

- Role of VR/AR in simulation for architectural walkthroughs.
- Mechanical assembly and design validation in VR environments.
- Electrical systems fault diagnostics using VR/AR.
- Tools: Unity, Unreal Engine, VR-enabled CAD tools.

Module 6: Data-Driven Modelling and Integration with IoT

- Introduction to data-driven modeling and predictive analytics.
- Integration with IoT for smart systems simulation.
- Digital twins for real-time simulation and monitoring.
- Case studies on smart buildings and smart grids.

Module 7: Environmental and Sustainability Simulations

- Energy efficiency modeling in buildings.
- Simulation of renewable energy systems (solar, wind, geothermal).
- Environmental impact analysis tools.
- Tools: RETScreen, HOMER, EcoDesigner STAR.

Module 8: Project-Based Learning and Case Studies

- **Cross-disciplinary projects focusing on:**
    - Structural and thermal performance of a building.
    - Simulation of manufacturing processes or HVAC systems.
    - Power system load flow and fault analysis.
- **Detailed study of real-world projects and their simulation-driven optimizations.**

Practical Exposure

- **Hands-on training on selected simulation tools in each discipline.**
- **Developing models and running simulations for specific engineering/architectural problems.**
- **Interpretation and presentation of simulation results.**