**University of Management and Technology**

**School of Architecture & Planning**

**Department of Architecture**

**Course Outline**

Course code: Ar 643 Course title: Building Energy Simulation and Design

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| --- | --- | --- |
| Program | M-ARCH | |
| Credit Hours | 3+0 | |
| Duration | One semester( 16 weeks) | |
| Prerequisites | None | |
| Resource Person | **As Per timetable** | |
| Counseling Timing | **Please see office window** | - |
| Contact | - | Email: |

**Chairman/Director signature………………………………….**

**Dean’s signature…………………………… Date………………………………………….**

The purpose of this course is to provide fundamental knowledge of building sciences for the development of high-performance buildings utilizing energy modeling and simulation technology as an energy performance analysis. Occupant comfort is also assessed using the simulation technology. Students calculate the energy consumption of heating, cooling, lighting, and other equipment by hand to understand the energy & thermal behavior of buildings, then compare and analyze these calculations with others calculated using energy modeling and simulation programs. Architecture and engineering students work together in this course, exchanging knowledge and collaborating to develop high-performance buildings, resulting in energy savings and environmental protections through greenhouse gas emission reductions.

**Learning Objective:**

* Discuss building sciences in terms of energy systems such as heating, cooling, lighting, and other mechanical equipment
* Utilize energy modeling and simulation technologies to analyze the energy and thermal performance of buildings
* Develop energy simulation models for design projects
* Discuss building Heating, Ventilating, and Air-Conditioning (HVAC) systems
* Analyze interactions between the HVAC and other energy systems

**Learning Methodology:**

* Lecturing
* Written Assignments
* Guest Speaker
* Field surveys
* Report Writing
* Term Project Submission

**Grade Evaluation Criteria**

Following is the criteria for the distribution of marks to evaluate final grade in a semester.

**Marks Evaluation Marks in percentage**

Quizzes 10%

Assignments 10%

Mid Term 30%

Term Project 20%

Final exam 30%

Total 100%

**Recommended Text Books:**

1. **Sustainability through Energy efficient Buildings** by Amritanshu Shukla

<https://www.routledge.com/Sustainability-through-Energy-Efficient-Buildings/Shukla-Sharma/p/book/9780367571863>

1. **A Handbook of Sustainable Building Design & Engineering** by Dejan Mumovic

<https://www.routledge.com/A-Handbook-of-Sustainable-Building-Design-and-Engineering-An-Integrated/Mumovic-Santamouris/p/book/9781032178547>

1. **Energy Smart Buildings, Design, Construction and Monitoring for improved Energy Efficiency** by Jacob J Lamb, Bruno G Pallet

<https://www.amazon.com/Energy-Smart-Buildings-Construction-Monitoring-Efficiency/dp/0750332573>

1. **Architecture and the Environment, Bioclimatic Building Design** by Jones

<https://www.amazon.com/Architecture-Environment-Contemporary-Bioclimatic-Buildings/dp/1856691039>

1. **Climatic Responsive Architecture: A design Handbook for Energy Efficient Buildings** by Arvind Krishan

<https://www.amazon.in/CLIMATE-RESPONSIVE-ARCHITECTURE-Efficient-Buildings/dp/0074632183>

**Calendar of Course contents to be covered during the semester**

Course code: Ar-643 Course title: Building Energy Simulation and Design

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| --- | --- | --- |
| **Week** | **Course Contents** | **Weeks** |
| 1 | Overview: Energy consumption of buildings in the US; Energy modeling & simulation; Energy systems in buildings | 1st Week |
| 2 | Energy Simulation and calculation  Software programs for energy simulation modeling (EnergyPlus, OpenStudio & SketchUp); Geometry modelling | 2nd Week |
| 3 | Energy Use in Buildings: Peak Heating Loads Calculation  Peak heating loads calculation; Loads simulation modeling-1 | 3rd Week |
| 4 | Energy Use in Buildings: Annual Heating Energy Calculation  Annual heating energy calculation; Loads simulation modeling-2 | 4th Week |
| 5 | Energy Use in Buildings: Peak Cooling Loads Calculation  Peak cooling loads calculation; Loads simulation modeling-3 | 5th Week |
| 6 | Energy Use in Buildings: Annual Cooling Energy Calculation  Annual cooling energy calculation; Loads simulation modeling-4 | 6th Week |
| 7 | Heating and cooling energy calculations & Simulation modelling | 7th Week |
| 8 | Mid Exam | 8th Week |
| 9 | Guest Lecture/ Guided tour by a mechanical engineer; HVAC systems, mechanical systems, and electrical systems | 9th Week |
| 10 | Energy Supply in Buildings: Heating, Ventilating, and Air- Conditioning (HVAC) Systems  Heating supply systems; Cooling supply systems; Ventilation systems; Air handing systems; Systems simulation | 10th Week |
| 11 | Energy Supply in Buildings: Psychrometrics Analysis  Building energy use characteristics; Psychrometric analysis for thermal energy analysis; Systems simulation-2 | 11th Week |
| 12 | Energy Supply in Buildings: Weather Analysis  Weather data analysis: Weather normalization; Energy consumption prediction; Energy performance evaluation; Systems simulation-3 | 12th Week |
| 13 | Exam-II & Student Project Presentation (Exam-II)  Energy supply systems & Systems simulation | 13th Week |
| 14 | Energy Performance Analysis: Energy Codes, Guidelines  Energy Use Intensity (EUI) analysis; CBECS/RECS, ASHRAE 90.1, LEED, & IPMVP; Whole building simulation | 14th Week |
| 15 | Submission of Term Project and Viva | 15th Week |
| 16 | Final Exam | 16th Week |