M. Arch (Sustainable Architecture) – II Year, III Semester 2024-25

MSAR211 - Design Studio - III - (Whole Building Simulation and Evaluation)

Syllabus Contents:

Introduction of simulation strategies related to thermal, visual, embodied energy performance of different components and parameters, energy analysis for building covering approximate methods, correlation methods, analytical methods, and numerical methods. Periodic heat transfer model of a non –air conditioned building comprising of heat balance equations for inside air, periodic heat flux through walls, roof, isothermal mass, conduction through floor/ ground, windows and heat loss through ventilation and infiltration etc., analysis of thermal trap roof and walls, solar thermal models for direct and indirect gain such as underground floor storage , earth air tunnels, earth covered structures, rock bed storage, phase change materials for conditioned and non-air conditioned buildings. DOE and TRNSYS, Energy Plus, Design Builder, IES and Radiance etc., simulation programmes for energy, light quantification for buildings. Calibration and validation studies for simulated contemporary and internationally recognised models / soft wares.

The simulation studio shall culminate into critical evaluation of applied strategies using advanced computation and simulation tools. The scale, size and typology of design are left to the faculty. Simulation studio requires a substantial dedication, and investment of student's time and skills, both during and after official class hours for using the tools and running the simulation. As a part of their involvement, students are required to actively participate in all lectures, discussions, readings, assignments, design tasks as a class group and/or individually. The design and lab-oriented work must be actively in progress on a daily basis for collection readings and development of design.

Studio Brief for M. Arch (Sustainable Architecture) III Semester Students

Tentative Studio Title:

Cool Roof Applications for Urban Heat Island (UHI) Reduction in Vijayawada

Objective:

To explore and apply cool roof technologies in mitigating Urban Heat Island (UHI) effects in Vijayawada, with a specific focus on low-income housing solutions. Students will use ENVI-met, Design Builder, and Urban Weather Generator (UWG) to simulate and analyze the impact of cool roofs on urban microclimates and neighborhood energy consumption.

Project Description:

Urban Heat Islands (UHI) are significant contributors to increased energy consumption, elevated emissions of air pollutants, and compromised human health and comfort. Cool roofs, with their high solar reflectance and thermal emittance, offer a promising solution to mitigate UHI effects. This studio will delve into the theoretical underpinnings and practical applications of cool roofs in the context of Vijayawada's climate. The project will include detailed architectural design problems focusing on low-income housing and neighborhood energy assessment using UWG.

Tools and Software:

- ENVI-met: For microclimate simulations and analysis.
- Design Builder: For building performance simulation.
- Urban Weather Generator (UWG): For Neighbourhood Energy Assessment.

Architectural Design Problem:

Low-Income Housing Solution with Cool Roof Integration

Design Challenge:

Develop a low-income housing project in Vijayawada that incorporates cool roof technology. The design should aim to:

1. Reduce indoor temperatures and improve thermal comfort.
2. Minimize energy consumption for cooling.
3. Enhance the overall sustainability of the housing project.
4. Address social, economic, and cultural aspects pertinent to the target population.
5. Assess neighbourhood energy consumption and efficiency using UWG.

Expected Deliverables:

1. **Site Analysis and Climatic Data Interpretation:** Analyze the site and interpret local climatic data using Urban Climates (2017) as a reference.
2. **Design Proposal:** Develop a comprehensive design proposal for the low-income housing project, integrating cool roof technology.
3. **Simulation and Analysis:** Use ENVI-met and Design Builder to simulate the impact of cool roofs on the microclimate and building performance.
4. **Neighbourhood Energy Assessment:** Use UWG to assess the impact of cool roofs on neighbourhood energy consumption – LOD 1 or LOD2 Level assessment.
5. **Impact Assessment:** Assess the environmental, economic, and social impacts of the proposed cool roof solutions.
6. **Presentation and Documentation:** Prepare a detailed report and presentation summarizing the findings, design process, and conclusions.

School of Planning and Architecture: Vijayawada

(An institution of National Importance under the Ministry of Human Resource Development, Govt. of India)
Survey No.4/4, ITI Road, Vijayawada-520008, Andhra Pradesh, India

Department of Architecture

Course: MSAR211 - Design Studio - III
(Whole Building Simulation and Evaluation)
Instructors: Dr. Faiz Ahmed & Prof. Dr. Iyer Vijayalaxmi Kasinath

Class: MSAR211 AY -24-25
Internal Assessment: 50
External JURY Exam: 50
Total Marks: 100
Credits: 15
50 % in Aggregate

Contact Periods/ week: 15 periods
Time Table: Monday-Thursday-Friday
Attendance: Min 75% **Min. Passing Marks:** 50% each in Internal & External Assessments

Objective:

To explore and apply cool roof technologies in mitigating Urban Heat Island (UHI) effects in Vijayawada, with a specific focus on low-income housing solutions. Students will use ENVI-met, Design Builder, and Urban Weather Generator (UWG) to simulate and analyze the impact of cool roofs on urban microclimates and neighborhood energy consumption.

Outcome of the Course:
Students completing this course will be able to:

- Develop a comprehensive design proposal for the low-income housing project, integrating cool roof technology.
- Use ENVI-met and Design Builder to simulate the impact of cool roofs on the microclimate and building performance.
- Use UWG to assess the impact of cool roofs on neighborhood energy consumption.

LECTURE PLAN

WEEK	TOPIC OF CLASS LECTURE & DISCUSSION	Remarks
1	**Introduction and Preliminary Research** Introduction to the studio brief and objectives. Literature review on UHI and cool roof technologies. Introduction to ENVI-met, Design Builder, and UWG.	Introductory Discussion
2	**Site & Context Analysis:** Site visits and data collection. Climatic analysis of Vijayawada using Urban Climates (2017).	Students Presentation / Discussion
3	**Site & Context Analysis:** Site visits and data collection. Climatic analysis of Vijayawada using Urban Climates (2017).	Students Presentation / Discussion
4	**Design Development - Conceptual Phase** Initial design concepts for low-income housing. Integration of cool roof technology in the conceptual design.	Students Presentation / Discussion
5	**Workshop 1 – ENVI-met**	1. Workshop ~ Invited Expert
6	**Mid-Semester Review:** Presentation of schematic designs and initial simulations. Mid-semester review with faculty and industry experts.	**MID-TERM ASSESSMENT -**

7	**Workshop 2 – Design Builder**	2. Workshop ~ Invited Expert
8	**Mid-term Assessment**	**MID-TERM ASSESSMENT - Evaluation**
9	**Workshop 3 – Urban Weather Generator**	3. Workshop ~ Invited Expert
10	**Detailed Design:** Refinement of design proposals based on feedback. Detailed architectural drawings and specifications.	Students Presentation / Discussion
11	**Simulation and Analysis - Part 1** Setting up ENVI-met and Design Builder models. Initial simulations to assess the impact of cool roofs.	Students Presentation / Discussion
12	**Simulation and Analysis - Part 2** Further simulations and analysis. Optimization of design based on simulation results.	Students Presentation / Discussion
13	**Neighborhood Energy Assessment: Part 1** Use of UWG to assess neighborhood energy consumption. Integration of neighborhood energy assessment results into the design.	Students Presentation / Discussion
14	**Neighborhood Energy Assessment: Part 2** Further simulations and analysis. Optimization of design based on simulation results.	Students Presentation
15	Review of submissions and documentation – Assessment III	Students Presentation
16	Review of submissions and documentation – Assessment III	Students Presentation

S. No.	Stages of Evaluation	Weightage
1	First stage: Assessment –1	10
2	Second stage: Mid-semester Examination	20
3	Third stage: Assessment –3	20
	Total	50

References:

1. Oke, T. R., Mills, G., Christen, A., & Voogt, J. A. (2017). Urban Climates. Cambridge University Press.
2. Gartland, L. (2012). The Urban Heat Island: Causes and Solutions. Earthscan.
3. Ritchie, A., & Thomas, R. (2012). Sustainable Urban Design: An Environmental Approach. Taylor & Francis.
4. Liu, K. (2013). *Green Roofs and Cool Pavements*. Building Research Information Knowledgebase.
5. Hensen, J., & Lamberts, R. (Eds.). (2011). Building Performance Simulation for Design and Operation. Spon Press.
6. Brackney, L., Long, N., & Deru, M. (2018). Building Energy Modeling with OpenStudio. Springer.

Course Instructors: **Head of Department:**

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Dr. Faiz Ahmed C & Prof. Dr. Iyer Vijayalaxmi Kasinath