I-SEMESTER

INTEGRATED DESIGN STUDIO I			
Course Code	23ASA11	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	03:09:00	SEE Marks	50
Total Hours of Pedagogy	12*16 = 192 hrs	Total Marks	100
Credits	12	Exam Hours	-

Course Learning objectives:

The Course aims to bring Architects in coherence with Ecological and Climatological aspects of planning and design.

This will reinforce them as rational thinkers integrated with creativity.

It will explore the technological expression in the field of Architecture and identity to design for being responsible for positive enhancement towards environment and society.

Module

Research Modules: Study reports and PPT presentations

- **Parametric Architecture design** approach integrating Aesthetics and sustainability aspects Case studies.
- **Water management systems from vernacular settlements:** (stepped wells, Jhalaras, Kunds), passive thermal comfort.
- **Renewable Energy sources:** Micro-wind, Micro hydro, Bio-methanization, Power generation by Magnets.
- **Climatological response by building envelope:** Solar Façade, Roof Pond/ Skytherm, Green walls, Green roofs, Roof radiation trap, Phase Change Materials (PCMs), EarthBerm Structures and corresponding energy efficient and passive thermal comfort.

Studio design with integration of vernacular, cultural, ecology and sustainability aspects in terms of city context, site study, site planning, building configuration, massing, functional zoning, daylight maximization, feasibility for natural or other passive ventilation and cooling, heating concepts, and efficient integration of MEP services.

Architectural integration of passive and hybrid cooling and ventilation systems, renewable energy systems for aesthetic uplift and green building elements and technology as not just an ADDON which can make the project compromise on the Architectural expression.

Teaching-Learning Process	***Direct method****: The lecture supported the conventional method of Blackboard and chalk to introduce concepts.* ***Interaction and discussion on drawing board, sketching and conceptualization, design development process, Computer Aided Design and Presentations****.* ***Evaluation by simulation****.* ***Blended learning:*** *Powerpoint presentation to elaborate more on key topics/online videos.*

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Viva voce is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in Viva is 50% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and Viva-Voce taken together.

Continuous Internal Evaluation:

CIE marks shall be awarded by a committee composed of Principal/Dean, PG Course Coordinator/ HOD and Guide/ Co-guide of the department. The CIE marks awarded for PSC(professional supportive course),shall be based on the progress of the student throughout the semester, presentation skills in seminars and submission of the report.

Viva voce Examination:

1.The student needs to submit his/her report done throughout the semester, including the data collection for the Viva examination, at least one day prior to the Viva examination to the PG course coordinator/HOD.

2.The exam shall be conducted as a panel jury exam which shall be minimum of 30 mins/student, where the student shall present the works in form of sheets.

3.Discussions, presentations and the studies should cover all the topics.

Suggested Learning Resources:

Books

- Net Zero Energy Buildings: A Guide to Designing, Building, and Operating High-Performance Buildings by Edward Mazria
- Net Zero Energy Design: Integrated Design Strategies for High-Performance Buildings by Thomas W. Heberlein and David J.
- The New Science of Building: How to Create Healthy, Energy-Efficient, and Sustainable Homes by Joseph Lstiburek
- Net Zero Energy Design: A Guide for Commercial Architecture by Tom Hootman
- Net Zero Energy Buildings: Case Studies and Lessons Learned" by Karsten Voss and Claus Steffan

Skill Development Activities Suggested

- Guest Lecture from expert.
- Site visit.
- Indian and International Case Studies to understand.

Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Students will be able to understand that the Environment is a resource with potential for recurring economic returns in a sustainable manner.	L1,L2
CO2	Students will be able to understand the ability to monetize environmental assets by valuing them as significant and needing protection, while reducing intrusive development and promoting low-impact development in harmony with nature.	L2
CO3	Students will be able to evaluate the economic impact of environmental measures that reduce economic performance in traditional models, but also will be able to develop alternate revenue sources to reward the commitment to environmental protection and promote them with incentives.	L4

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**H**	**H**	**H**	**M**	**L**	**0**
CO2	**H**	**H**	**H**	**H**	**L**	**0**
CO3	**H**	**L**	**L**	**L**	**L**	**0**

I-SEMESTER

BUILDING PHYSICS AND PASSIVE DESIGN			
Course Code	23ASA12	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	04:01:00	SEE Marks	50
Total Hours of Pedagogy	05*16 = 80 hrs	Total Marks	100
Credits	05	Exam Hours	3

Course Learning objectives:

The Course aims to give an technical understanding of climatic parameters which influence the building design and better utilization and operation of the building in terms of response to climate, occupants thermal comfort, visual comfort and energy efficiency.

Module-1

Climate types like Moderate, Warm and Humid, Hot and Dry, Composite, COLD and CLOUDY, annual variations and impact of it on built environment and climatological design approach in various climates of India and other climate typologies around the world. With Detailed understanding of weather outdoor parameters like DBT, WBT, RH, AH, Solar Insolation, Wind velocity, Precipitation, Inversion, Learning thorough measurements and relation between them.

Module-2

Theory of Sun path analysis (understanding Altitude angle, Azimuth angle, Angle of incidence, Angle of reflection, variation of solar radiation across the globe and reasons), Solar Passive architecture planning configuration, massing and design with sun path analysis, mutual shading, facade shading sizing and design, basics of daylight assessment, optimization and still controlling the heat gain and corresponding thermal comfort.
Module-3
Theory on Outdoor thermal comfort, wind movement and utilization (Venturi effect, wind shadow, Positive pressure façade, Negative pressure facades, Air turbulence nodes, spacing to height ratio between buildings), Urban Heat Island effect, impact of landscape typologies on the campus and city level planning of spaces, activities etc.
Module-4
Material Science: Thermal Physics basics (modes of heat transfer conduction, convection and radiation) and building material thermal and light properties: U-value, Thermal lag, Thermal conductivity, Thermal conductance, Thermal Emissivity, diffusivity, Sensible heat gain, Latent Heat gain, Thermal Resistance, Thermal Bridging, Solar Reflective Index - SRI, Solar Heat Gain Coefficient, Visible light transmittance and parameters, theory, calculations, Use of simple software tools for the same.
Module-5
Theory and manual calculations: Natural ventilation in buildings, basic principles and conceptual understanding of the Passive ventilation (solar Chimney, Stack ventilation, Cross ventilation enhancement by space planning, sizing and fenestration sizing and location), hybrid ventilation, Passive Cooling and heating (PDEC - wind catchers, trombe walls, Solarium, concepts and corresponding fluid dynamics, venturi effect and its benefits in space planning and facade design, Thermal storage wall, water wall, Transwall, Thermal storage / Isolated Gain, Evaporative cooling (Direct, indirect, Sensible evaporative cooling), Nocturnal radiative cooling, Passive desiccant cooling, Vary therm wall and related thermal comfort. Lab-Demonstrations of passive strategies on the campus. Stack effect, Wind catchers,PDEC, External and internal shading, Heat reflective tiles and paints, Sun pipes, efficient glazing, could be designed.
Module-6
INDOOR Standard Human Thermal comfort and Adaptive Human Thermal comfort, Asymmetric thermal comfort: parameters for indoor occupant spaces (Dry Bulb Temperature, Wet Bulb Temperature, Relative Humidity, Absolute Humidity, Air density, CLO value, METABOLIC RATE Value, Air velocity, Mean Radiant Temperature, Zone Operational Temperature) and Introduction to Psychrometric charts, Bioclimatic chart, Design Day calculations, Diurnal temperature variations and benefits. Related WELLNESS factors.
Module-7
Daylight studies understanding Solar spectrum, Utilizable and non-utilizable daylight, types of sky conditions in various climates, Daylight factor, Direct component, reflected component, ground reflection, Sky component, Outdoor sky illuminance, Daylight guiding techniques into buildings like optical fiber based and sunpipes, Human eye light sensitivity and utilization, Visual discomfort glare and Glare index in respect to cone of vision of occupant towards the daylight source.

Teaching-Learning Process	***Direct method****: Lecture supported by conventional methods of Blackboard and chalk to introduce the concepts.* ***Blended learning:*** *Powerpoint presentation to elaborate more on key topics.* ***Lab based learning with measurements and simulation evaluation tools***

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour 30 min)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 13th week of the semester

Two assignments each of 10 Marks

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks(duration 01 hours)

At the end of the 16th week of the semester, the sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

- The question paper will have ten questions.
- Each question is set for 20 marks.
- There will be 2 questions (with a maximum of four sub questions in one full question) from each module.
- Each full question will cover the contents under a module.
- The students have to answer 5 full modules, selecting one full question from each module.

Suggested Learning Resources:

Books

- **Indoor Thermal Comfort**
    - Human Thermal Comfort By Ken Parsons
    - Thermal Comfort: Principles and Applications by Fanger et al.
    - Thermal Comfort: From Physiology to Architecture by Michael Humphreys
    - Thermal Comfort: A Handbook of Principles and Applications by Michael J. Humphreys
    - Indoor Environmental Quality and Thermal Comfort" by Yacine Ait-Mahieddine
    - Thermal Comfort: Analysis and Applications in Environmental Engineering" by Devdas Menon
- **Passive Heat and Cooling Design**
    - Passive Solar Architecture Heating, Cooling, Ventilation, Daylighting and More Using Natural Flows By David Bainbridge, Ken Haggard
    - Passive Solar Heating and Cooling Design by Edward Mazria
    - Passive Cooling: Design Strategies and Solutions by Mark J. DeKay
    - Passive Solar Design for the 21st Century by Bruce Anderson
    - Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows" by David A. Bainbridge
    - Passive Cooling" by James Kachadorian
- **Daylight in the Built Environment and Integration with Artificial Lighting**
    - Daylighting and Integrated Lighting Design" by Christopher Meek, Kevin Van Den Wymelenberg, and Gregory Ward
    - Light: Nature's Creation, Science, and Technology by Howard E. Gruber
    - Lighting Design: Principles and Applications by Mark S. Rea
- **Climate responsive ARCHITECTURE for tropical climates**
    - Climate Sensitive Architecture: Principles and Practice by Mark Baker
    - Tropical Architecture: Passive and Low-Energy Design by Victor Olgyay
    - The Architecture of Climate: Bioclimatic Building Principles by Givoni
    - Architecture and Climate: An Environmental History of British Architecture 1600-2000" by Dean Hawkes
    - Architecture and Climate: Designing for Low Energy Buildings" by Olgyay and Olgyay
    - Architecture in Hot Climates" by P. Olley and J. Olley
    - Designing for Climate Change: Strategies for Sustainable Buildings and Communities" by Peter F. Smith
    - Tropical Sustainable Architecture: Social and Environmental Dimensions" by Marie-Hélène Contal and Françoise Pambrun
    - Tropical Architecture: Critical Regionalism in the Age of Globalization" by Asia's urban think tank, the Urban Redevelopment Authority

Skill Development Activities Suggested

- Guest Lecture from Industrial experts.
- Site visits.
- Indian and International Case Studies to understand.

Web links and Video Lectures (e-Resources):

Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Understanding of all tropical and cold climates of India and major climates worldwide.	L2
CO2	Starting points of climate responsive architecture planning and design.	L2,L3
CO3	Understanding vernacular architecture planning and design principles and resources utilization.	L1,L2
CO4	Understanding of Passive design aspects of climatological design for space ventilation, cooling, heating and related thermal comfort and related standards.	L4
CO5	Understanding of preferred human thermal comfort indoors for passive, active and hybrid systems and related standards.	L4
CO6	Understanding of Daylight utilization, controls and energy saving in relation with site planning, building planning, massing and façade design	L4,L5

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**H**	**H**	**H**	**M**	**L**	**0**
CO2	**H**	**H**	**H**	**H**	**L**	**0**
CO3	**H**	**H**	**M**	**M**	**H**	**0**
CO4	**H**	**H**	**H**	**M**	**H**	**M**
CO5	**L**	**M**	**H**	**M**	**H**	**0**
CO6	**L**	**M**	**H**	**M**	**H**	**0**

I-SEMESTER

FUNDAMENTALS OF LIGHTING AND HVAC			
Course Code	23ASA13	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	04*16 = 64 hrs	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

The Course aims to bring Architects in coherence with integration of electro mechanical systems with a creative aspect to it.

Enhances the capability of an architect to think of energy efficiency in projects which is not restrictive to built forms, but still within the international standards definitions.

Module-1

Basics of Heating Ventilation and Air-conditioning:

- Brush up on basics of HVAC and related thermal comfort parameters from undergraduate syllabus.
- Introduction to ASHRAE standards.
- Introduction to Latest HVAC technologies today in the national and international market with their positive impact on energy efficiency, thermal comfort and wellness aspects.
- Critical aspects understanding of all HVAC components and their role in energy efficiency of the systems. Understanding of efficiency parameters COP, EER, IPLV, SEER, Watt/CFM, Diversity factors for efficient system sizing based on building typology and functional schedules.
- Energy efficiency control components, VFD, EC motors, Direct drive fans.

Module-2

Understanding working principles of:Radiant cooling and heating, chilled beams, Phase Change Materials (PCMs) integrated HVAC systems, Under floor Air distribution, Individual thermal comfort control. Introduction to ASHRAE standards for all components of HVAC.

Air quality control components: Filter types and standards, UV sterilizers, Ionizers, Scrubbers.

Module-3

Basics of Artificial lighting design learning by measurements: Introduction to Basics of light physics, Luminaire Photometric and parameters (CRI, Color temperature, Wattage, Lumens, LUX, Foot candle, Ballast factor, Ballast Power factor, Light Power Density, Lux sensors, Occupancy sensors, Dual sensors) etc and various lighting technologies with understanding of its selection parameters, application parameters,

Module-4

Introduction to IESNA standards. Critical aspects of understanding of all Lighting components and their role in energy efficiency of the systems. Related WELLNESS factors with Lux levels and circadian lighting.

Teaching-Learning Process across all modules	***Direct method****: Lecture supported by conventional methods of Blackboard and chalk to introduce the concepts.* ***Blended learning:*** *Powerpoint presentation with case studies from India and worldwide to elaborate more on key topics.* ***Lab based learning with measurements and simulation evaluation tools***

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour 30 min)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 13th week of the semester

Two assignments each of 10 Marks

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks(duration 01 hours)

At the end of the 16th week of the semester, the sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

- The question paper will have ten questions.
- Each question is set for 20 marks.
- There will be 2 questions (with a maximum of four sub questions in one full question) from each module.
- Each full question will cover the contents under a module.
- The students have to answer 5 full modules, selecting one full question from each module.

Suggested Learning Resources:

Books

Basics of HVAC

- Simplified Design of HVAC Systems By William Bobenhausen
- HVAC Systems and Equipment: Design and Applications by William M. C. Boyce
- Fundamentals of HVAC Systems by William M. C. Boyce
- HVAC Systems and Controls: A Practical Guide by William H. McShane
- HVAC Design Sourcebook" by W. Larsen Angel
- Fundamentals of HVAC Systems" by Robert McDowall.

Basics of Lighting

- International Lighting Design By V. Lorenzo Porcelli, Donna Green
- Lighting Design: Principles and Applications by Mark S. Rea
- Lighting Design Handbook by Bill Speck
- Lighting Design: A Visual Approach by Mark S. Rea and Richard K. Weller
- Lighting Design Basics" by Mark Karlen and Christina Spangler
- Architectural Lighting: Designing with Light and Space" by Herve Descottes and Cecilia E. Ramos

Skill Development Activities Suggested

- Guest Lecture from expert.
- Site visits / Interaction with practitioners

Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Basics of HVAC systems and related parameters for design of MEP as integral part of building design.	L2,L3
CO2	Understanding of application and feasibility analysis parameters of conventional and innovative HVAC system technologies worldwide for integral design	L2
CO3	Technical and aesthetical aspects of lighting design for an integrated approach. Also related energy efficiency with daylight integration	L3
CO4	Design of lighting with understanding of standards in an innovative approach	L3

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**L**	**M**	**H**	**M**	**H**	**M**
CO2	**L**	**M**	**H**	**H**	**M**	**L**
CO3	**L**	**L**	**M**	**M**	**H**	**L**
CO4	**L**	**L**	**H**	**M**	**H**	**L**

I-SEMESTER

PERFORMANCE EVALUATION OF BUILDING - I			
Course Code	23ASA14	CIE Marks	100
Teaching Hours/Week (L:S:SDA)	01:02:01	SEE Marks	-
Total Hours of Pedagogy	04*16 = 64 hrs	Total Marks	100
Credits	03	Exam Hours	-

Course Learning objectives:

To investigate the simulation and audit techniques for assessing the energy performance, environmental response and impact of built form.

Module-1

Introduction to Building Performance Evaluation

Emerging role of performance evaluation in building design and Master Planning. Integrated approach to environmental design. Cognitive, analytical and simulated modeling and design of buildings.

Integrated energy modeling, thermal zoning simplification for simpler un complicating the model with softwares like IES-VE, DESIGN BUILDER EnergyPlus, Rhino Grasshopper integrated with all LADYBUG, HONEYBEE and Butterfly tools plugins, Basics of PYTHON Scripting.

Module-2

Environmental Assessment Methods

Modeling and experimental techniques for building assessment/evaluation and design. Standard Human Thermal comfort and Adaptive Human Thermal comfort parameters . Understanding of ASHRAE thermal comfort tools, PMV tools. Issues and opportunities with current assessment modes/evaluation tools.

Module-3

Integrated Modeling

Introduction to Integrated energy modelling, thermal zoning simplification for the model with softwares like IES-VE, DESIGN BUILDER EnergyPlus, Rhino Grasshopper integrated with all LADYBUG, HONEYBEE and Butterfly tools plugins.

Module-4

Python Scripting

Introduction to Python scripting to build capability of customizing the programs for parametric architectural modeling integrated with sustainable design, analysis and arriving at solutions .

Assessment Details (only CIE)

The weightage of Continuous Internal Evaluation (CIE) is 100%. The minimum passing mark for the CIE is 50% of the maximum marks.

Continuous Internal Evaluation:

Integration between the Integrated sustainable studio and Performance Evaluation of Building is mandatory. Assignments can be given to aid this.

Three major assignments

- First assignment at the end of 5th week of the semester
- Second assignment at the end of the 10th week of the semester
- Third assignment at the end of the 13th week of the semester

Other exercises during the studio time or can be given as assignments through the duration of the semester.
Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs.

At the end of the 16th week of the semester, the sum of three assignments, exercise, and quiz/seminar/group discussion will be out of 100 marks.

Suggested Learning Resources:

Books

- Python for Everybody: Powerful Object-Oriented Programming by Bill Lubanovic
- Kabele, K., Modeling and analyses of Passive solar systems with computer simulation, in Proc. Renewable energy sources, PP. 39 – 44, Czech Society for Energetics Kromeriz 1998.
- James Douglas "Building Adaptation", Elsevier, Oxford2002.
- Clarke, J.A., Energy Simulation in building design, Adam Hilger Ltd, Bristol,1985
- Automate the Boring Stuff with Python by Al Sweigart
- Python Crash Course: A Hands-On, Project-Based Introduction to Programming by Eric Matthes
- Fluent Python: Clear, Concise, and Effective Programming by Luciano Ramalho
- Effective Python: 90 Specific Ways to Write Better Python by Brett Slatkin

Web links and Video Lectures (e-Resources):

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Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Understanding experimental techniques for building assessment.	L2,L3
CO2	Understanding the impact of built form on the environment.	L2
CO3	Understanding issues and opportunities with current assessment modes /evaluation tools.	L2
CO4	Understanding scripting to customize the program.	L2,L3

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**M**	**M**	**H**	**M**	**H**	**M**
CO2	**H**	**M**	**H**	**M**	**H**	**L**
CO3	**M**	**L**	**H**	**M**	**H**	**L**
CO4	**0**	**0**	**L**	**L**	**H**	**L**

I-SEMESTER

SUSTAINABILITY AND ENVIRONMENT			
Course Code	23ASA15	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	03:00:01	SEE Marks	50
Total Hours of Pedagogy	04*16 = 64 hrs	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:
The Course aims to create designers and thinkers with clear understanding of impacts of building and infrastructure on the macro and micro level ecological aspects. Also expanding their knowledge on the global impacts, their role to mitigate the negative impacts.

Module-1

Introduction to Basics of **Climate change and Global Warming** worldwide scenario, Global agreements, Policies. Direct and In-direct impacts of Climate change policies and agreements on Building industries.

Module-2

Introduction to Basics of **Biodiversity loss, over-exploitation of natural resources**, air & water pollution and their relationship with the built environment.

Module-3

Basics of hydrology and water sustainability and management With introduction to Site Ecology related to hydrology (flora, Fauna, Urban Agriculture, and Water efficient Landscape), Rain water harvesting and ground water table improvisation techniques, rainwater storage systems, Wastewater treatment (recycle) and REUSE, efficient irrigation systems, Water efficient water fixture selection. Government policies in India and worldwide.
Understanding the critical design considerations for Water management system design at Urban services planning, campus level, low rise buildings, high-rise buildings, sky scrapers, industrial buildings, Health care projects, Institutional projects, Mass transport buildings and related Energy, water use and efficient systems

Module-4

Basics of Waste management: With introduction to Types of Waste segregation methodology, Recyclable Waste reuse and Upcycling, Power generation from organic waste, worm composting, Government policies in India and worldwide.
Understanding the critical design considerations for Waste management system design at Urban services planning, campus level, low rise buildings, high-rise buildings, sky scrapers, industrial buildings, Health care projects, Institutional projects, Mass transport buildings and related Energy, water use and efficient systems

Module-5

Understanding **vernacular Architecture** Case study projects in terms of climatological response by Sustainable Architectural master planning, building zoning, planning, massing, material selection in terms of local availability and methodology of usage, Passive ventilation, cooling and heating methods used, Thermal comfort research from literature studies (or Thermal comfort Audits if given access) etc.

Teaching-Learning Process across all modules	***Direct method****: The lecture supported the conventional method of Blackboard and chalk to introduce sustainability as a long term process and not one time effort. Discussions, Debate, Industry interactions for the same.* ***Blended learning:*** *Powerpoint presentation to elaborate more on key topics/online video's/ live examples of projects etc.*

Assessment Details (both CIE and SEE)
The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour 30 min)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 13th week of the semester

Two assignments each of 10 Marks

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks(duration 01 hours)

At the end of the 16th week of the semester, the sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

- The question paper will have ten questions.
- Each question is set for 20 marks.
- There will be 2 questions (with a maximum of four sub questions in one full question) from each module.
- Each full question will cover the contents under a module.
- The students have to answer 5 full modules, selecting one full question from each module.

Suggested Learning Resources:

Books

- DRAWDOWN: The Most Comprehensive Plan Ever Proposed To Reverse Global Warming - PAUL HAWKEN
- THIS CHANGES EVERYTHING: CAPITALISM VS THE CLIMATE - NAOMI KLEIN
- Principles of Sustainability by Simon Dresner, 2005 Earth Scan
- Sustainable Architecture by Simon Guy and Steven Moore 2005, SPON press
- THE UNINHABITABLE EARTH: LIFE AFTER WARMING - DAVID WALLACE-WELLS

Skill Development Activities Suggested

- Guest Lecture from expert.
- Indian and International Case Studies to understand.

Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Students have an understanding of the implication of building industry on climate change and Biodiversity.	L2
CO2	To have understanding of approaches with lower ecological footprint for the master planning and building design.	L2
CO3	Understanding of importance towards water resources and decision making of project carrying capacity accordingly to try and achieve NETZERO water footprint.	L2,L3
CO4	Understanding of importance towards Waste segregation, management, upcycling and use of waste for power generation. This helps in achieving NETZERO waste footprint.	L2,L3

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**H**	**H**	**H**	**M**	**L**	**L**
CO2	**H**	**M**	**H**	**H**	**M**	**L**
CO3	**L**	**L**	**M**	**M**	**H**	**L**
CO4	**L**	**L**	**H**	**M**	**H**	**L**

I-SEMESTER

RESEARCH METHODS - MATERIAL SCIENCE - AUDIT COURSE			
Course Code	23ASA16A	CIE Marks	-
Teaching Hours/Week (L:S:SDA)	-	SEE Marks	-
Total Hours of Pedagogy	-	Total Marks	-
Credits	-	Exam Hours	-

Course Learning objectives:
The Course is designed as an elective with the focus on research on material science. Students can research on modern materials or reusing traditional material in a modern way. They may critically look at sustainable aspects of material right from cradle to grave.

I-SEMESTER

INDIGENOUS KNOWLEDGE SYSTEM - AUDIT COURSE			
Course Code	23ASA16B	CIE Marks	-
Teaching Hours/Week (L:S:SDA)	-	SEE Marks	-
Total Hours of Pedagogy	-	Total Marks	-
Credits	-	Exam Hours	-

Course Learning objectives:
The Course is designed as an elective with the focus on understanding the idea of sustenance as being maintainable over a longtime. Traditional Knowledge systems allow us to understand lifestyle and cultural choices that have become ingrained in people from simple dietary choices to planning principles based on resource availability to infrastructure management.

Module-1

Study of Traditional buildings case studies and analysis based on climate, cultural practices and beliefs and an understanding of passive and active systems used as climatic responses that have sustained overtime.

Module-2

Study of Traditional Planning principles and zoning laws driven by industry and type of work.

Module-3

Understanding the impact of available resources and infrastructure in the development of sustained cultural and traditional practices such as building construction, social space creation and management and infrastructure development, ownership and operations.

Module-4

Traditional stimulants for trade, economic activity and other requirements that drove local economies. Traditional methods and practices related to water harvesting, management and curation of and maintenance of public spaces, gardens and amenities

Module-5

Ecologically sensitive responses of various traditional knowledge systems to their surrounding context, climate and other natural and environmental phenomena.

Suggested Learning Resources:

- Traditional Ecological lKnowledge: Learning from Indigenous Practices for Environmental Sustainability, MelissaK.Nelson, DanielShilling
- Sustaining Traditional Agricultural Practices for Food Security, VKDubey, Shailendra Nath Ghosh

— — — END OF SEMESTER — — —

II-SEMESTER

INTEGRATED DESIGN STUDIO II			
Course Code	23ASA21	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	03:09:00	SEE Marks	50
Total Hours of Pedagogy	12*16 = 192 hrs	Total Marks	100
Credits	12	Exam Hours	-

Course Learning objectives:

The Course aims to bring Architects in coherence with Ecological and Climatological aspects of planning and design. This will reinforce them as rational thinkers integrated with creativity. Also giving a new meaning for technological expression in the field of Architecture and identity to design for being responsible for positive enhancement towards environment and society.

Module

Studio design with integration of vernacular, cultural, ecology and sustainability aspects in terms of city context, site study, site planning, building configuration, massing, functional zoning, daylight maximization, feasibility for natural or other passive ventilation and cooling, heating concepts, and efficient integration of MEP services.

Architectural integration of passive and hybrid cooling and ventilation systems, renewable energy systems for aesthetic uplift and green building elements and technology as not just an ADDON which can make the project compromise on the Architectural expression.

Daylight integration design with control strategies of Artificial lighting (As part of Integrated Design Studio project), with Simulation assignments of medium and Large scale projects, and corresponding Carbon Emission Reduction as per international Benchmarks.

Capital Expenditure (CAPEX), Operational Expenditure (OPEX) and Return of Investment (RoI).

Project Deliverables:

- Design Project Typology and site finalization, Site visit and annual Climatic analysis report (evaluation tools also to be used) (1 week),
- Research modules to be learnt with case studies and aspects to be incorporated in Studio project (2 weeks).
- Architectural, climatological concepts in relation to site, city and local materials and cultural context to be developed (2 weeks).
- Planning, Design methods, evaluation methodology in terms of Architecture, ECM analysis, CAPEX, OPEX and RoI, (5 weeks).
- Working on a design project towards finalization of plan, sections, elevations and materials finalization, Passive, active and hybrid system conceptualization and architectural incorporation of the same in an aesthetic manner as a response to climate, simulation evaluation and reporting - (6 weeks).

Teaching-Learning Process	***Direct method**: The lecture supported the conventional method of Blackboard and chalk to introduce concepts.* ***Interaction and discussion on drawing board, sketching and conceptualization, design development process, Computer Aided Design and Presentations**.* ***Evaluation by simulation**.* ***Blended learning:** Powerpoint presentation to elaborate more on key topics/online videos.*

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Viva voce is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in Viva is 50% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and Viva-Voce taken together.

Continuous Internal Evaluation:

CIE marks shall be awarded by a committee composed of Principal/Dean, PG Course Coordinator/ HOD and Guide/ Co-guide of the department. The CIE marks awarded for PSC(professional supportive course),shall be based on the progress of the student throughout the semester, presentation skills in seminars and submission of the report.

Viva voce Examination:

1. The student needs to submit his/her report done throughout the semester, including the data collection for the Viva examination, at least one day prior to the Viva examination to the PG course coordinator/HOD.
2. The exam shall be conducted as a panel jury exam which shall be minimum of 30 mins/student, where the student shall present the works in form of sheets.
3. Discussions, presentation and the studies should cover all the topics.

Suggested Learning Resources:

Books

Skill Development Activities Suggested

- Guest Lecture from expert.
- Site visit.
- Indian and International Case Studies to understand.

Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Students will be able to understand the vernacular, cultural, ecology and sustainability aspects in terms of city context, site study, site planning, building configuration, massing.	L1,L2,L3
CO2	Students will be able to understand the Architectural integration of passive and hybrid cooling and ventilation systems,daylight integration design with control strategies of Artificial lighting (As part of Integrated Design Studio project), with Simulation.	L3,L4
CO3	Students will be able to evaluate Capital Expenditure (CAPEX), Operational Expenditure (OPEX) and Return of Investment (RoI)	L4,L5

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**H**	**H**	**M**	**M**	**L**	**0**
CO2	**H**	**H**	**H**	**M**	**H**	**M**
CO3	**L**	**L**	**H**	**M**	**H**	**H**

II-SEMESTER

RESOURCE CONSERVATION AND EFFICIENCY			
Course Code	23ASA22	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	04:00:02	SEE Marks	50
Total Hours of Pedagogy	06*16 = 96 hrs	Total Marks	100
Credits	05	Exam Hours	3

Course Learning objectives:

The Course extends the knowledge on Direct and indirect resources and embodied energy involved in the building industry, their present availability, extinctions, reduce, recycle, reuse and upcycling of materials at end of their life cycle.
To understand holistic CRADLE to CRADLE approach.
To understand Urban Design aspects of sustainability and approach to NETZERO in terms of Energy, Water and Waste.

Module-1

Life Cycle Analysis (LCA): basics and related parameters as /goal definition and scope, Inventory analysis, impact assessment, Interpretation and evaluation, Integration of LCA in decision making, Life cycle Cost assessment.LCA software evaluations

Module-2

Project **Embodied Energy** types and understanding calculations for building, Materials and systems. Capital Expenditure (CAPEX), Operational Expenditure (OPEX) and Return of Investment (RoI), project Ecological Footprint, implication on climate change. Expert sessions by industrial experts.

Module-3

Case studies of **NET ZERO ENERGY, WATER and WASTE** projects around the world in different climate types. Methodology for **NET ZERO Carbon footprint** planning, design, and execution, Operation & Maintenance, NET ZERO Water and Waste.
Module-4
Urban Design Sustainability approach: Climatology considerations for Urban design in terms of UHIE, Wind patterns, Wind Chill, impact of urban landscape and water bodies on human comfort level micro climate, cooler urban interaction spaces, Solar Cities and smart cities, smarter integration of city level renewable energy with urban design.Software analysis for UHIE, Wind patterns, Shadow analysis etc. Case studies, reporting and presentation.

Teaching-Learning Process	***Direct method****: Lecture supported by conventional methods of Blackboard and chalk to introduce the concepts.* ***Blended learning:*** *Powerpoint presentation to elaborate more on key topics.*

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour 30 min)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 13th week of the semester

Two assignments each of 10 Marks

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks(duration 01 hours)

At the end of the 16th week of the semester, the sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

- The question paper will have ten questions.
- Each question is set for 20 marks.
- There will be 2 questions (with a maximum of four sub questions in one full question) from each module.
- Each full question will cover the contents under a module.
- The students have to answer 5 full modules, selecting one full question from each module.

Suggested Learning Resources:

Books

Life cycle assessment LCA

- Life Cycle Assessment: Principles and Practice by J.A.F.A. Keoleian and B.A. Menerey
- Life Cycle Assessment Handbook: A Guide for Environmentally Sustainable Products by Mary Ann Curran

Net Zero Energy Building Design

- Net Zero Energy Buildings: A Guide to Designing, Building, and Operating High-Performance Buildings by Edward Mazria
- Net Zero Energy Design: Integrated Design Strategies for High-Performance Buildings by Thomas W. Heberlein and David J.

Urban Design Sustainability approach

- Alexander, C. Pattern Language, Oxford University Press, 1977.
- Farr, D. Sustainable Urbanism: Urban Design with Nature, John Wiley &Sons Inc,2007.
- Emmanuel., R., An urban approach to climate sensitive design: strategies for the tropics, Span Press, Taylor and Francis Group,2005.
- UDPFI Guidelines, Part I and Part II. Ministry of Urban development and Poverty Alleviation, Government of India,1996.

Skill Development Activities Suggested

- Lectures and Guest Lectures from experts.
- Indian and International Case Studies to understanding like Living Building Challenge – LBC or LEED or IGBC certified NETZERO Energy and CARBON projects etc.

Web links and Video Lectures (e-Resources):

Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Understanding of design aspects in terms of Life cycle of the project and mitigation measures for extended responsibility and CRADLE to CRADLE approach.	L2
CO2	Understanding of project footprint on ecology resources and energy use intensity.	L1,L2
CO3	Understanding of micro and macro level aspects of sustainable approaches to urban design and its integration with urban space and functional planning.	L2
CO4	Understanding design of projects with ZERO impact on Energy, water and waste.	L3,L4

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**H**	**H**	**M**	**M**	**L**	**L**
CO2	**H**	**H**	**H**	**L**	**H**	**M**
CO3	**M**	**H**	**H**	**M**	**H**	**L**
CO4	**L**	**M**	**H**	**M**	**H**	**H**

II-SEMESTER

GREEN BUILDING TECHNOLOGIES			
Course Code	23ASA23	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	04*16 = 64 hrs	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

The Course aims to give an technical understanding of how to design buildings which are responding to climate, smart to regulate human comfort conditions, optimize energy based on usage percentage, inturn manage energy, water consumption, smart energy systems by using renewable resources with grid and off grid and captive energy generation systems (project level energy generations).

Module-1

Spectrally Selective Films, Electrochromic Glazing and films, PCM facades, NANOGEL panels, Building Integrated Photovoltaic, Heat reflective indoor blinds, Automated creative façades, shading and controls.

Module-2

Renewable energy technologies, feasibility and applications today and future: Solar PV and farms with Solar tracking system, Solar Hot water, Solar steam generation and cooking, Solar thermal power generation, Solar Air-conditioning, Solar pool heating, Solar Hot water with heat pump integration, Solar hot water with glycol heat exchanger, Micro and Mega wind energy systems, Helical Wind turbines, Hydro power (Macro and Micro)

Module-3

Captive power generations: Steam Plant, Gas turbine with centralized gas supply, Bio-Methanation gas supply to gas engine, Co-generation of power and waste heat for Vapour Absorption Machines (VAM chillers) for Air-conditioning, Super heat recovery for Hot water generation.

Module-4

IOT based sensor technology and Integrated Building management systems (IBMS) monitoring and control and Energy Management Systems (EMS), IAQ monitoring and management systems with related ASHRAE codes of design standards, Space utilization pattern and intensity analysis helping in arriving at infrastructure revision approaches, cost control etc.

Teaching-Learning Process across all modules	***Direct method****: Lecture supported by conventional methods of Blackboard and chalk to introduce the concepts.* ***Blended learning:*** *Powerpoint presentation with case studies from India and worldwide to elaborate more on key topics.*

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour 30 min)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 13th week of the semester

Two assignments each of 10 Marks

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks(duration 01 hours)

At the end of the 16th week of the semester, the sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

- The question paper will have ten questions.
- Each question is set for 20 marks.
- There will be 2 questions (with a maximum of four sub questions in one full question) from each module.
- Each full question will cover the contents under a module.
- The students have to answer 5 full modules, selecting one full question from each module.

Suggested Learning Resources:

Books

- Large-Scale Solar Power System Design: An Engineering Guide for Grid-Connected Solar Power Generation, 1st Edition - Peter Gevorkian.
- Solar Engineering of Thermal Processes Fourth Edition John A. Duffie (Deceased) Emeritus Professor of Chemical Engineering William A. Beckman Emeritus Professor of Mechanical Engineering Solar Energy Laboratory University of Wisconsin-Madison.
- A-B-C of Captive Power Plants -GoutamBandopadhyay.
- Power Generation Operation and Control – Allen J Wood, Bruce F Wollenberg.
- Renewable Energy and Smart Grid technologies, V.K.Jain and Sudhir Kumar.
- SCADA and Power Systems – Praveen Arora.
- SCADA in Energy Management – Tanuj Kumar Bisht.
- Building Management System for Beginners – HAMZA MOHAMED ANSARI.
- Sustainable Smart Grid for SELF-RESILIENT Electricity Sector. – Dr. Neeraj Kumar, Dr. Nitin S Patil, Dr. V.M.Nikale.
- Sustainable Facades, AJLA AKSHAMIJA – Perkins and Wills.
- Dynamic Façade Systems – Impact Evaluation through Simulation and Calculation – SinzianaRasca.
- IoT for Green Building Management WayesTushar, Senior Member, IEEE, Nipuni Wijeratne, Wen-Tai Li, Member, IEEE, Chau Yuen, Senior Member, IEEE, H. Vincent Poor, Fellow, IEEE, Tapan Kumar Saha, Senior Member, IEEE, and Kristin L. Wood

Skill Development Activities Suggested

- Guest Lecture from expert.
- Site visits / Interaction with practitioners

Web links and Video Lectures (e-Resources):

- C. Arumugam et al._Air-conditioning cost saving and CO2 emission reduction perspective of buildings designed with PCM integrated blocks and roofs Sustain. Energy Technol. Assessments (2021)
- Q. Al-Yasiri et al._Incorporation of phase change materials into building envelopes for thermal comfort and energy saving: a comprehensive analysis J. Build. Eng.
- Solar Power in Building Design the Engineer's Complete Design Resource By Peter Gevorkian.

Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Understanding of alternative systems of energy generation.	L2
CO2	Understanding of renewable energy based cooling and heating systems.	L2
CO3	Understanding of integrated energy management and technology based indoor environment and climate responsive systems, controls and management.	L3,L4
CO4	Understanding of new technologies for building envelope heat gain and heat loss control.	L3,L4

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**L**	**L**	**H**	**M**	**M**	**H**
CO2	**L**	**M**	**H**	**H**	**H**	**L**
CO3	**L**	**M**	**H**	**M**	**H**	**M**
CO4	**L**	**M**	**H**	**M**	**H**	**M**

II-SEMESTER

PERFORMANCE EVALUATION OF BUILDING - II			
Course Code	23ASA24	CIE Marks	100
Teaching Hours/Week (L:S:SDA)	01:02:01	SEE Marks	-
Total Hours of Pedagogy	04*16 = 64 hrs	Total Marks	100
Credits	03	Exam Hours	-

Course Learning objectives:

The Course aims to give an technical understanding pre-construction and post construction evaluation of how to design buildings which are responding to climate, smart to regulate human comfort conditions, optimize energy based on usage percentage, in turn manage energy, smart energy systems by using renewable resources with grid and off grid and captive energy generation systems (project level energy generations).

Module-1

Introduction to Building Performance Evaluation

Emerging role of performance evaluation in building design and Master Planning. Integrated approach to environmental design. Cognitive, analytical and simulated modeling and design of buildings.

Integrated energy modeling, thermal zoning simplification for simpler un complicating the model with softwares like IES-VE, DESIGN BUILDER EnergyPlus, Rhino Grasshopper integrated with all LADYBUG, HONEYBEE and Butterfly tools plugins, Basics of PYTHON Scripting.

Module-2

Performance evaluation of project at pre construction stage

site planning, UHEI, Building floor plate optimization, planning configuration, functional zoning, Massing optimization for mutual shading, direct solar heat control, daylight maximization, Parametric architecture analysis, Energy Conservation Measures (ECM-Design stage),Anticipated CO2 emission and embodied energy carbon footprint,

Module-3

Post construction evaluation

Post construction evaluation for all parameters with softwares like IES-VE, DESIGN BUILDER EnergyPlus, Rhino Grasshopper integrated with all LADYBUG, HONEYBEE and Butterfly tools plugins.

Assessment Details (only CIE)

The weightage of Continuous Internal Evaluation (CIE) is 100%. The minimum passing mark for the CIE is 50% of the maximum marks.

Continuous Internal Evaluation:

Integration between the Integrated sustainable studio and Performance Evaluation of Building is mandatory. Assignments can be given to aid this.

Three major assignments

- First assignment at the end of 5th week of the semester
- Second assignment at the end of the 10th week of the semester
- Third assignment at the end of the 13th week of the semester

Other exercises during the studio time or can be given as assignments through the duration of the semester.
Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs.

At the end of the 16th week of the semester, the sum of three assignments, exercise, and quiz/seminar/group discussion will be out of 100 marks.

Suggested Learning Resources:

Books

- IES Building Performance Modelling Student Handbook.
- Design Builder Performance Modelling Tutorials.
- RETSCREEN Renewable Energy analysis software Tutorials.

Web links and Video Lectures (e-Resources):

- Ladybug, HoneyBee, Butterfly learning online tutorials in integration with Rhino Grasshopper.

Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Understanding of sustainable site planning and infrastructure for Large scale projects.	L2
CO2	Understanding of Building planning and design aspects with integration of sustainability parameters.	L2
CO3	Pre-construction evaluation of conceptualization, design finalization of building and MEP.	L4,L5
CO4	Post construction and operational evaluation of the implemented sustainability concepts to be working as they have to.	L4,L5

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**H**	**M**	**M**	**L**	**H**	**M**
CO2	**M**	**H**	**H**	**M**	**H**	**M**
CO3	**L**	**L**	**H**	**M**	**H**	**M**
CO4	**L**	**L**	**M**	**L**	**H**	**M**

II-SEMESTER

ELECTIVE I _ SUSTAINABLE INTERIORS			
Course Code	23ASA25A	CIE Marks	100
Teaching Hours/Week (L:S:SDA)	01:01:00	SEE Marks	-
Total Hours of Pedagogy	02*16 = 32 hrs	Total Marks	100
Credits	02	Exam Hours	-

Course Learning objectives:
The Course is designed as an elective with the focus on sustainable interiors. Having dealt with the site building in two semesters, this elective looks in detail on how the interior can also be sustainable. It will look at materials in detail, reuse of them, life span, energy etc.

II-SEMESTER

ELECTIVE I _ POST OCCUPANCY EVALUATION OF BUILDINGS			
Course Code	23ASA25B	CIE Marks	100
Teaching Hours/Week (L:S:SDA)	01:01:00	SEE Marks	-
Total Hours of Pedagogy	02*16 = 32 hrs	Total Marks	100
Credits	02	Exam Hours	-

Course Learning objectives:
The Course is designed as an elective with the focus on sick Building Syndrome reasons, analysis and solutions during Planning, design of new projects and also Retrofit solutions for existing projects.
Post-Occupancy comfort and wellness survey and analysis methodology and Occupants performance assessment case studies with understanding on tangible and intangible benefits to users, employers etc

Suggested Learning Resources:

- Sick Building Syndrome: What It Is and Tips for PreventionOccupants Health Safety 2016.
- Approaches for predicting long-term sickness absence. Re: Schouten et al. "Screening manual and office workers for risk of long-term sickness absence: cut-off points for the Work Ability Index"_Scand J Work Environ Health 2015

II-SEMESTER

RESEARCH METHODS - SYSTEM AND TECHNOLOGY - AUDIT COURSE			
Course Code	23ASA26A	CIE Marks	-
Teaching Hours/Week (L:S:SDA)	-	SEE Marks	-
Total Hours of Pedagogy	-	Total Marks	-
Credits	-	Exam Hours	-

Course Learning objectives:
The Course is designed as an elective with the focus on research on system and technology. Students can research various system and technique which could inform their per thesis/thesis.

II-SEMESTER

SUSTAINABLE DEVELOPMENT LAWS IN INDIA - AUDIT COURSE			
Course Code	23ASA26B	CIE Marks	-
Teaching Hours/Week (L:S:SDA)	-	SEE Marks	-
Total Hours of Pedagogy	-	Total Marks	-
Credits	-	Exam Hours	-

Course Learning objectives:
The Course is developed to focus on regulatory mechanisms and commitments to environmental protection and regulation, while ensuring that long terms goals of country can be achieved - a perspective on why regulation is needed in the larger scheme of things, while we also look at how and what day to day impacts are there on businesses, development and implementation of projects.

— — — END OF SEMESTER — — —

III-SEMESTER

BUILDING PERFORMANCE AND ANALYSIS STUDIO			
Course Code	23ASA31	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	03:09:00	SEE Marks	50
Total Hours of Pedagogy	12*16 = 192 hrs	Total Marks	100
Credits	12	Exam Hours	-

Course Learning objectives:

The Course aims to bring Architects in coherence with Ecological and Climatological aspects of planning and design. This will reinforce them as rational thinkers integrated with creativity. Also giving a new meaning for technological expression in the field of Architecture and identity to design for being responsible for positive enhancement towards environment and society.

Module

Site selection, Building Typology selection, under a particular Climate type for campus planning and design project.

Campus level criteria based approach learning from LBC, GRIHA, IGBC, LEED Methodology for aspects like Built and unbuilt, Site ecology aspects like Flora, Fauna, Green Leaf index, Pre-and Post UHIE (simulation based), Pre-and Post-Percolation and achieving ZERO Discharge from site, ZERO discharge of construction waste, ZERO discharge of Organic waste and reused for campus landscape and energy generation from waste.

Campus planning and zoning, building configuration to reduce the direct solar heat gain in tropical climates and increase direct solar heat gain in COLD climate. Optimization of daylight utilization with integration of façade glazing optimization and appropriate building material selection for building envelope, Facade shading etc.

Building space planning , zoning and massing configurations as a climate response for sustainable space planning by regulation and utilization of wind, light, Solar access in integration with passive cooling, heating and other Hybrid systems and related energy savings.

Performance based Energy modeling of Larger scale residential, commercial, institutional, Industrial and Hospitality, Health care projects in line with the various green building tools methodology of defining Base case and arriving at recommended proposed case to attain required and exemplary level of energy efficiency.

MEP systems:Preliminary design, typology finalization and sizing of the systems for the respective above listed building typologies selected.

Simulation based NET ZERO Energy, Carbon emission approach including all master planning, Architecture and MEP aspects. Simulation based LCA and embodied energy analysis and methodology to reduce the project ecological footprint.

Understanding in detail all related criteria under the selected green building tool system and also learning the assessment tool in terms of using calculators, reporting, review etc.

Project Deliverables:

- Design Project Typology and site finalization, Site visit and annual Climatic analysis report (evaluation tools also to be used). Research modules to be learnt with case studies and aspects to be incorporated in Studio project (1 week).

- Simulation based campus planning, building configuration planning, floor plate optimization, massing configuration, envelope design and optimization, Material selection in terms of local context and ECM analysis, MEP system selection and preliminary analysis and calculations. (2 weeks)

- Planning, Design methods, evaluation methodology with green building assessment tools in terms of campus, Architecture, MEP, CAPEX, OPEX and RoI, LCA and embodied energy calculations (5 weeks).

- Working on design project towards finalization of plan, sections, elevations and materials finalization, Passive, active and hybrid system conceptualization and architectural incorporation of the same in an aesthetic manner as a response to climate, and reporting with presentation - (8 weeks).

Teaching-Learning Process	***Direct method**: The lecture supported the conventional method of Blackboard and chalk to introduce concepts.* ***Interaction and discussion on drawing board, sketching and conceptualization, design development process, Computer Aided Design and Presentations**.* ***Evaluation by simulation**.* ***Blended learning:** Powerpoint presentation to elaborate more on key topics/online videos.*

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Viva voce is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in Viva is 50% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and Viva-Voce taken together.

Continuous Internal Evaluation:

CIE marks shall be awarded by a committee composed of Principal/Dean, PG Course Coordinator/ HOD and Guide/ Co-guide of the department. The CIE marks awarded for PSC(professional supportive course),shall be based on the progress of the student throughout the semester, presentation skills in seminars and submission of the report.

Viva voce Examination:

1. The student needs to submit his/her report done throughout the semester, including the data collection for the Viva examination, at least one day prior to the Viva examination to the PG course coordinator/HOD.
2. The exam shall be conducted as a panel jury exam which shall be minimum of 30 mins/student, where the student shall present the works in form of sheets.
3. Discussions, presentation and the studies should cover all the topics.

Suggested Learning Resources:

Books

Skill Development Activities Suggested

- Guest Lecture from expert.
- Site visit.
- Indian and International Case Studies to understand.

Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Students will be able to understand the campus level criteria based approach learning from LBC, GRIHA, IGBC, LEED, methodology for built and unbuilt, site ecology aspects etc.	L2,L3
CO2	Students will be able to understand performance based Energy modeling of Larger scale residential, commercial, institutional, Industrial and Hospitality, Health care projects in line with the various green building tools.	L4
CO3	Students will be able to evaluate simulation based NET ZERO Energy, Carbon emission approach including all master planning, Architecture and MEP aspects	L5

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**L**	**M**	**H**	**M**	**H**	**M**
CO2	**L**	**L**	**H**	**L**	**H**	**H**
CO3	**L**	**L**	**H**	**L**	**H**	**H**

III-SEMESTER

PEOPLE, ENVIRONMENT AND BUILDINGS			
Course Code	23ASA32	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	04:00:02	SEE Marks	50
Total Hours of Pedagogy	06*16 = 96 hrs	Total Marks	100
Credits	05	Exam Hours	3

Course Learning objectives:
Sustainable development, Assessment and validation as per international standards of city planning and urban design, architecture, systems, materials, building operation and maintenance.
Attaining projects with NET ZERO, Environmental Impact is becoming a basic requirement for all sectors today.
Macro level sustainability aspects assessment and analysis using GIS and remote sensing empowers the analytical process and expense.

Module-1

Introduction to Green building assessment tools like LEED, ECBC, IGBC, GRIHA, EDGE, LBC, WELL, BEE INDIA etc. Assignments for detailed understanding of criteria are of above listed Green building assessment tools under various building typologies.

Module-2

Environmental Impact assessment - EIA: Scoping and Screening, Baseline Studies, Impact Identification, Impact assessment and Evaluation, Stakeholders Engagement, Cumulative Impact assessment, Mitigation and management plans, Environmental monitoring and Auditing, Reporting and documentation as per EIA draft 2020..

Module-3

Sustainable Community Development: Economic development, environmental protection, Social Equality and inclusion, culture, Sustainable Transportation, Green Urbanism and infrastructure, Affordable and sustainable housing, Community engagement and participation, Education and awareness.

Module-4

Disaster Resilient infrastructure: Introduction to Resilient infrastructure and Management, Prevention Of Hazard, Structural and Non-Structural Mitigation Measures, Existing Framework for Disaster Resilient infrastructure and Management, Community Based Disaster Resilient infrastructure and management.

Module-5

GIS and Remote sensing: Introduction to Geographical Information System (GIS), Application of GIS System And Remote Sensing, Overview Of Remote Sensing, Remote Sensing Technology, Data Processing

Teaching-Learning Process	***Direct method****: Lecture supported by conventional methods of Blackboard and chalk to introduce the concepts.* ***Blended learning:*** *Powerpoint presentation to elaborate more on key topics.* ***Lab based learning with measurements and simulation evaluation tools***

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of 20 Marks (duration 01 hour 30 min)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 13th week of the semester

Two assignments each of 10 Marks

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for 20 Marks(duration 01 hours)

At the end of the 16th week of the semester, the sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50 marks

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)

- The question paper will have ten questions.
- Each question is set for 20 marks.
- There will be 2 questions (with a maximum of four sub questions in one full question) from each module.
- Each full question will cover the contents under a module.
- The students have to answer 5 full modules, selecting one full question from each module.

Suggested Learning Resources:

Books

Environmental Impact Assessment (EIA)

- Environmental Impact Assessment: A Practical Guide by David J. Canter
- Environmental Impact Assessment: A Guide to Best Practice by the International Association for Impact Assessment
- Environmental Impact Assessment: An Introduction by David Wood
- Environmental Impact Assessment: Theory and Practice by Michael B. Gerrard

Sustainable Community Development

- Sustainable Development: A Global Perspective by John J. Kirton and Peter W. Evans
- Sustainable Development: From Concept to Practice by Michael Redclift and David Goodman.
- Sustainable Development: The Role of Local Actors by David Gibbs and David Humphreys

Resilient Infrastructure and management

- Arnold, C and Reitherman, R. Building Configuration and Seismic Design. JohnWiley and Sons, New York,1982.
- Carter, WN. Disaster Management: A Disaster Manager's Handbook, AsianDevelopment Bank, Manila,1990.
- Farrington, K. Natural Disasters – The Terrifying forces of nature, Grammery Books, London,1999.
- Sharma, VK. Disaster Management, Rawat Publications, Jaipur,1995.
- United Nations. Disaster Prevention and Mitigation, United Nations DisasterRelief Organization,1986.

GIS and Remote sensing

- Lillesand, T.M. and Kiefer, R.W, Remote sensing and image interpretation, John Wiley and sons, New York,2004.
- GolfriedKonechy, Geoinformation: Remote sensing, Photogrammetry and Geographical Information Systems, CRC press, 1st Edition,2002.
- Burrough, P.A. and McDonnell, R.A., Principles of Geographic Information systems Oxford University Press, New York,2001.
- Lintz, J. and Simonet, Remote sensing of Environment, Addison Wesley Publishing Company, New Jersey,1998.

Skill Development Activities Suggested

- Lectures and Guest Lectures from experts.
- Indian and International Case Studies to understanding like Living Building Challenge – LBC or LEED or IGBC certified NETZERO Energy and CARBON projects etc.

Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Understanding of national and international Green building assessment tools for substantiating the sustainability approach and innovations.	L1,L2
CO2	Understanding intangible impacts of any development and construction project on the environment during construction and post construction throughout its life cycle.	L2
CO3	Understanding of Sustainability development methodology and various aspects critical to be planned for long-term sustainability and accommodate future developments and changes along its life cycle.	L2
CO4	Understanding of disaster management aspects to plan and design resilient infrastructure and construction.	L4

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**L**	**M**	**L**	**H**	**L**	**H**
CO2	**L**	**L**	**M**	**H**	**M**	**H**
CO3	**L**	**L**	**M**	**H**	**L**	**H**
CO4	**H**	**H**	**M**	**M**	**L**	**M**

III-SEMESTER

PROFESSIONAL TRAINING / INTERNSHIP			
Course Code	23ASA33	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	-	SEE Marks	50
Total Hours of Pedagogy	-	Total Marks	100
Credits	03	Exam Hours	-

Course Learning objectives:

To provide exposure to the various aspects of Sustainable development and Architecture practice. Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently

Module

The student will be exposed to preparation of sustainable drawings, detailed project reports, preparation of feasibility report, computer applications in design and drafting, filing system in respect of documents, drawing and preparation of tender documents.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Viva voce Examination:

1. The student needs to submit his/her report done throughout the semester, including the data collection for the Viva examination, at least one day prior to the Viva examination to the PG course coordinator/HOD.
2. The exam shall be conducted as a panel jury exam which shall be minimum of 30 mins/student, where the student shall present the works in form of sheets.
3. Discussions, presentation and the studies should cover all the topics.

Course Outcomes

At the end of the course the student shall have

• Training Report: This shall contain copies of only such drawings, which have been dealt, drafted or designed by students. It shall also contain a brief description of works handled during the training.

• Report Study – This shall include a detailed critical study of a project from the office related to Sustainable development.

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Gain practical experience within the industry in which the internship is done.	L3
CO2	Acquire knowledge of the industry, experience the activities and functions of professionals.	L3,L4
CO3	Identify areas for future knowledge and skill development.	L4
CO4	Expand intellectual capacity, credibility, judgment, intuition	L4

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**L**	**M**	**H**	**H**	**H**	**H**
CO2	**L**	**L**	**H**	**H**	**H**	**M**
CO3	**L**	**M**	**M**	**H**	**M**	**L**
CO4	**L**	**M**	**L**	**H**	**M**	**M**

III-SEMESTER

RESEARCH METHODOLOGY			
Course Code	23ASA35	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	02:00:01	SEE Marks	50
Total Hours of Pedagogy	03*16 = 48 hrs	Total Marks	100
Credits	02	Exam Hours	-

Course Learning objectives:
At the end of the course the student will be able to: develop the research skills in a systematic manner which will impart the ability to select appropriate research methodology, experimental design, follow professional ethics and academic integrity, and develop written presentation skills.

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.
Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.
Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.
Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Techniques, Multidimensional Scaling, Deciding the Scale.
Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.
Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Teaching-Learning Process	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Viva voce Examination:

1. The student needs to submit his/her report done throughout the semester, including the data collection for the Viva examination, at least one day prior to the Viva examination to the PG course coordinator/HOD.
2. The exam shall be conducted as a panel jury exam which shall be minimum of 30 mins/student, where the student shall present the works in form of sheets.
3. Discussions, presentation and the studies should cover all the topics.

Suggested Learning Resources:

Books

- Research Methodology: Methods and Techniques, C.R. Kothari, GauravGarg,New Age International,4th Edition, 2018.
- Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), RanjitKumar, SAGE Publications,3rd Edition, 2011.
- Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.
- Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009

Skill Development Activities Suggested

- Guest lecture
- Review of research papers
- Workshops / seminars by industry experts
- Site visits / case studies

Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Prepare an extensive literature study and data collection from the field and presentation in the form of drawings, relevant details/codes, schematic charts, reports and photographs	L3
CO2	Develop a hypothesis to be tested through the research methodology designed for the purpose with innovative insight on specific issues thereby undertaking academic research independently.	L3
CO3	Experiment with research processes.	L4
CO4	Propose areas for further research and development	L5

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**M**	**H**	**L**	**H**	**L**	**M**
CO2	**M**	**M**	**L**	**H**	**H**	**L**
CO3	**M**	**M**	**H**	**H**	**M**	**M**
CO4	**L**	**H**	**H**	**H**	**H**	**M**

III-SEMESTER

ELECTIVE II _ SUSTAINABLE LANDSCAPE			
Course Code	23ASA35A	CIE Marks	100
Teaching Hours/Week (L:S:SDA)	01:01:00	SEE Marks	-
Total Hours of Pedagogy	02*16 = 32 hrs	Total Marks	100
Credits	02	Exam Hours	-

Course Learning objectives:
The Course is designed as an elective with the focus on sustainable Landscape. Landscape design methods for water efficiency and corresponding energy use reduction, Water efficient irrigation systems and automated controls for water saving, Sustainable landscaping integrated with food production to achieve ZERO food miles, Urban planning and design aspects of sustainable landscaping along with its importance for maintaining ecological balance and reduced heat island effect.

III-SEMESTER

ELECTIVE II _ INTELLIGENT BUILDINGS			
Course Code	23ASA35B	CIE Marks	100
Teaching Hours/Week (L:S:SDA)	01:01:00	SEE Marks	-
Total Hours of Pedagogy	02*16 = 32 hrs	Total Marks	100
Credits	02	Exam Hours	-

Course Learning objectives:
The Course aims to bring Architects in coherence with integration of electro mechanical systems with a creative aspect to it. Enhances the capability of an architect to think of energy efficiency in projects which is not restrictive to Built forms, but still within the international standards definitions. Biophilic and Biomimetic design can also be explored.

— — — END OF SEMESTER — — —

IV-SEMESTER

THESIS PROJECT			
Course Code	23ASA41	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	03:20:00	SEE Marks	50
Total Hours of Pedagogy	23*16 = 368 hrs	Total Marks	100
Credits	23	Exam Hours	-

Course Learning objectives:

The Course aims to give the students an opportunity to go through the entire process of project conception, and development of a sustainable project from conception to realization. They will be on a path to present a case for a project, justify the decision making from an economic, environmental and empathetic perspective. They will go through the process of handling various panels of review to get their project cleared for success.

Module

Teaching-Learning Process	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Viva voce is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in Viva is 50% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and Viva-Voce taken together.

Continuous Internal Evaluation:

CIE marks shall be awarded by a committee composed of Principal/Dean, PG Course Coordinator/ HOD and Guide/ Co-guide of the department. The CIE marks awarded for PSC(professional supportive course),shall be based on the progress of the student throughout the semester, presentation skills in seminars and submission of the report.

Viva voce Examination:

1. The student needs to submit his/her report done throughout the semester, including the data collection for the Viva examination, at least one day prior to the Viva examination to the PG course coordinator/HOD.
2. The exam shall be conducted as a panel jury exam which shall be minimum of 30 mins/student, where the student shall present the works in form of sheets.
3. Discussions, presentation and the studies should cover all the topics.

Suggested Learning Resources:

Books

Skill Development Activities Suggested

Course Outcomes

At the end of the course the student will be able to:

Sl. No.	Particulars	Blooms Level
CO1	Students will be able to develop a strong project outline, without applied thoughts to all aspects of the project	L3
CO2	Present a compliant case that covers all technical requirements of the project with strategies that will show technical acumen in being able to respond to the requirements of the regulatory frameworks, rating systems and other evaluation systems available	L4
CO3	Students will be able to go beyond the normal and understand how this can be stretched to maximize sustainability in the given context by addressing out of the box ideas and developing solutions to resolve them - not just compliant by being truly sustainable.	L5

Note to Guides and Students in Project Selection for Thesis:

It is important to look at the complexity of the overall project in the context of issues to be addressed and the flow of arguments that will build this narrative for it and the solutions that can be provided. The student's success is not necessarily linked to the complexity of scale of the project but more on the issues that need to be overcome and the value additions that can be made to the process - hence everything from a rural rehabilitation scheme to eco-tourism, industrial parks, smart cities (Greenfield or Brownfield) can be taken up pursuant to the ability of the student to address all of these steps as a process and come through it with an understanding of how to truly be sustainable.

Program Outcome of the SA Program

Sl. No.	Particulars	POs
1	Approach building design in context with city and site specific ecology aspects.	PO1
2	Apply the knowledge of Vernacular architecture and passive design strategies and material technologies from ancient wisdom.	PO2
3	Develop design skills in Energy and water Efficient Design and intelligent Buildings.	PO3
4	Structure the research study, learning and incorporation of them in planning, design, reporting and implementation.	PO4
5	Use simulation tools for improving overall building performance during the master planning, architectural planning, design and design development process, MEP design and development process.	PO5
6	Appraise architectural design and assist for documentation for Green building certifications and environmental clearances.	PO6

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**L**	**M**	**H**	**H**	**M**	**L**
CO2	**M**	**M**	**M**	**H**	**H**	**L**
CO3	**M**	**M**	**M**	**H**	**H**	**M**

IV-SEMESTER

OPEN ELECTIVE			
Course Code	23ASA42	CIE Marks	50
Teaching Hours/Week (L:S:SDA)	01:01:00	SEE Marks	-
Total Hours of Pedagogy	02*16 = 32 hrs	Total Marks	50
Credits	02	Exam Hours	-

Course Learning objectives:

— — — END OF SEMESTER — — —