Contents

REVISED
CBCS 2018 COURSE
FOR
POST GRADUATE DEGREE PROGRAMME
IN
M. ARCH. (Sustainable Architecture)

Sustainable Development

Subject Code : SA 101			
Teaching Scheme		**Examination Scheme**	
Teaching	4 hours/week	Credits	4
Teaching hours/ semester	60 hours	University examination (UE)	60 marks
Hours for Internal Assessment	12 hours	Internal Assessment (IA)	40 marks

Aim:
To enable students to understand the impact of development activities on the state of environment and need for sustainable development.

Learning Outcome:
At the end of semester the student will understand:

- The impact of human activity on the environment
- The concept and practice of sustainable development
- Ways of reducing and repairing environmental damage and related laws.
- Principles of sustainable site planning and role of landscape in energy conservation

Unit I	**Environment and sustainability**	10 hours
	• Basic concepts of Ecology, ecosystems • Biodiversity- types and value of biodiversity, • Environmental Degradation, • Need for sustainable development, • Basic principles of sustainable development.	
Unit-II	**Global Environmental Concerns and Mitigation Measures**	08 hours
	• Global environmental concerns, • Clean development mechanism • Methodologies for sustainable development • Sustainable development Goals (SDG 11 specifically goals towards built environment)	
Unit III	**Environmental Laws, Impact Assessment and management**	12 hours
	• Environmental impact assessment – Characteristics, methodologies and process • Environmental clearance process in India • Laws – Air Act, water Act, Environmental Protection Act • Protection and preservation of trees rules 2009 • National green tribunal Act 2010 • Wastewater Management Authority Act • Solid waste management and handling rules • MOEF guidelines for Eco sensitive zones	
Unit IV	**Sustainable Cities**	12 hours
	• Urbanization and Environment • Urban Environmental Issues (such as air and noise pollution, water pollution, transport, urban heat island, urban green	

	spaces, solid waste management) • Status of Environment, Sustainable development for built environment • Concept of Sustainable Cities and Framework for Sustainable Cities • Smart City And its Components	
Unit V	**Sustainable Site Planning**	10 hours
	• Site and microclimate • Site potential and constraints • Site planning principles and assessment • Checklist for sustainable site planning • Green campus policies and planning-case studies	
Unit VI	**Sustainable Landscapes**	08 hours
	• Slope analysis, Topography and Drainage • Landscape and microclimate • Water conservation with respect to site only • Role of vegetation in energy conservation, selection of plants • Green roofs and terraces, vertical gardens	
Sessional work: Unit tests and assignments based on above content		
IA: Please refer to the guidelines given in the annexure		
Text Books and References		

- www.smartcities.gov.in/
- UN(2013)World Economic and Social Survey 2013
- Global Sustainable Development Report 2015
- Basic Ecology, Odum E. P. 1983, Holt-Seunders intl. ed. Japan
- Miller T.G.Jr. Environmental Science, Wadsworth Publishing Co. (TB)
- Understanding Sustainable Development-John Belwitt
- Stephen Schneider, Armin Rosencranz, Michael Mastrandrea, eds., 2010.
- Bert Metz, 2010. Controlling climate change, Cambridge University Press.
- Canter L.W. (1996) *Environmental Impact Assessment*, 2nd Edn. New York, McGraw Hill
- Trivedy R.K., Handbook of Environmental Law, Acts, Guidelines, Compliances and Standards, Volume Environment Media, 1996.
- Mohanty S. K., Environment and Pollution Law Manual, Universal Law Publishing Company ltd., 3rd edition, 2002
- Pollution Control Acts, Rules and Notifications, Pollution Control Law Series – Volume – I, Central Pollution Control Board, 1992
- Dr. P. Khanna ,Premier on Environment Management, 2001, multi- tech publishing co.
- Robinette, G.O (1977) Landscape planning for energy conservation. Environmental Design Press,Reston, VA
- Starke .B and Simonds. J. O. (2013) Landscape Architecture: A Manual of Site Planning and Design. McGraw-Hill Professional
- TERI (2009) Sustainable Building, Design Manual, Volume I and Volume II

Energy Management and Audit

Subject Code : SA 102			
Teaching Scheme		**Examination Scheme**	
Teaching	4 hours/week	Credits	4
Teaching hours/ semester	60 hours	University examination (UE)	60 marks
Hours for Internal Assessment	12 hours	Internal Assessment (IA)	40 marks

Aim:
Introduction of various Aspects of Energy Management and Audit to assess the energy performances of built spaces.

Learning Outcome :
At the end of semester the student will understand:

- General aspects of Energy in buildings
- Energy Management and Conservation Opportunities in Buildings
- Energy Audits

Unit I	**General Aspects of Energy and Energy Scenario**	12hours
	Classification of Energy, Primary and Secondary Energy, Commercial and Non-commercial Energy, Renewable and Non-Renewable Energy, Global Primary Energy Reserves and Commercial Energy Production of Coal, Oil, Natural Gas, Global Primary Energy Consumption, Final Energy Consumption, Indian Energy Scenario Coal, Oil, Natural Gas, Electrical Energy Supply, Sector wise Energy Consumption, Energy Needs of Growing Economy, Energy Intensity, Energy Pricing in India, Long term Energy Scenario in India, Energy Security and Energy Independence, Energy Conservation and Energy Efficiency.	
Unit-II	**Basics of Energy and Various Forms of Energy**	6 hours
	Forms of Energy-Potential and Kinetic, Electrical Energy, Basics of Thermal Energy, Energy Content in Fuels, Heat Transfer, Steam Properties, Laws of Thermodynamics, Energy Units & Conversion, Concept of Fuel Pricing and Electricity Bill	
Unit III	**Energy Conservation Acts, Related Policies, Electricity Act and Energy Conservation Building Code**	12hours
	Salient Features of The Energy Conservation Act 2001 & The Energy Conversion (Amendment) Act 2010, Salient Features of The Electricity Act 2003,Present Status of Implementation, Introduction to Energy Conservation Building Code 2007 and 2017, energy performance index, determining EPI ratios	
Unit IV	**Energy Audit**	14 hours
	Definition & Objectives of Energy Audit and Management, Definition of Energy Audit, Need for Energy Audit, Types of Energy Audit & Approach, Technical and Economic Feasibility of ENCON Measures, Energy Audit Report, Energy Costs, Benchmarking, Energy Performance, Fuel and Energy Substitution, Need for	

	measurement parameters and Instruments, Scope and Coverage of Energy Audit of Commercial and Residential Buildings.	
Unit V	**Energy Management**	8 hours
	Concepts of Material and Energy Balance, Sankey Diagram. Key Elements and Principles of Energy Management, Energy Policy & Planning, Force Field Analysis of Energy Management, Implementation of Energy Management.	
Unit VI	**Financial Management and Management of Energy Efficiency Projects**	8 hours
	Investment in Energy Efficiency and Appraisal Criteria for Investment, Financial Analysis Techniques, Simple Payback Period, Return on Investment, Time Value of Money, Net Present Value, Internal Rate of Return, Salvage value, Energy Performance Contracting and Energy Service Companies and Case Study What is an Energy Efficiency Project? Pre-planning, Planning project implementation, Project evaluation, Measurement and Verification of Energy Efficiency Project.	
Sessional Work: Unit tests and assignments based on contents above		
IA: Please refer to the guidelines given in the annexure		

Text Books and References

- Books Published by Bureau of Energy Efficiency, New Delhi – Book -1.
- Energy Conservation Building Code Document Issued by Bureau of Energy Efficiency, New Delhi
- Encyclopedia of Energy – McGraw Hill publication
- Handbook of E. Engineering – The Fairmont Press Inc. Albert Thumann
- E. Handbook, Van Nostrand Reinhold Co. – Robert L. Loftness.
- Cleaner Production – E. E. Manual for GERIAP, UNAP, Bankok, Prepared by National Productivity Council.
- B. P. Statistical Review of World Energy, June 2003.
- International Energy Outlook, March 2002, Energy Information admin., Office of integrated analysis and forecasting, U. S. DOE, Washington.
- Indian Planning Commission statistics.
- The Energy and Resources Institute (TERI).
  Web sites – www.bp.com/centres/energy, www.eia.doe.gov www.epa.org
- Training material on "Environmental Concerns" NPC.
- Parivesh – October 2002, Central Pollution Board.
- Web sites – www.uneptie.org , www.cpcb.nic.in ,
  www.wri.org , www.safe climate.net , www.globalwarming.org
- E. Dictionary – Van Nostrand Reinhold, V. Daniel Hunt Co. New York.
- Web sites www.eia.doe.gov/kids/btudef.html
  www.calculator.org/properties.html ,

www.katmarsoftware.com

Sustainable Design Studio-I

<table>
<tr><td colspan="4">Subject Code : SA 103</td></tr>
<tr><td colspan="2">Teaching Scheme</td><td colspan="2">Examination Scheme</td></tr>
<tr><td>Teaching</td><td>10 hours/week</td><td>Credits</td><td>10</td></tr>
<tr><td>Teaching hours/ semester</td><td>150 hours</td><td>University examination (UE)</td><td>60 marks</td></tr>
<tr><td>Hours for Internal Assessment</td><td>30 hours</td><td>Internal Assessment (IA)</td><td>40 marks</td></tr>
<tr><td colspan="4">Aim :
To translate sustainable design principles into architectural design concepts and application of environmental modeling and simulation tools and techniques to building design.</td></tr>
<tr><td colspan="4">Learning Outcome:
At the end of the semester the student will be able review different approaches of solar passive architecture in building design.</td></tr>
<tr><td>Unit I</td><td colspan="2">Studio :Project Description</td><td>120 hrs</td></tr>
<tr><td></td><td colspan="2">Design project of Area between range of 3000-5000 sq.m. built up to respond to Thermal Environments using scientific methods of design namely analysis techniques, design strategies and system integration and evaluation procedures.
Or
Design Studio to apply the Solar Passive Principles at all scales for their Graduation Thesis project.
Students shall also perform Energy Simulation exercise for their design solution using energy simulation software e. g. Ecotect or similar.
Design Methodology:
1. Completion of data collection / bask graphic work related to climate and site
2. Data base & data processing, analysis, projection & graphic presentation of climate and site
3. Formulating Approach / parameters for proposed design / plan / model
4. Design / plan / model proposals and details
5. Implementation/application solar passive strategies with calculations both manual and simulation
6. Evaluation, conclusion including cost - benefit appraisal for relevance of the work.

The entire work will be contained in a comprehensive report and portfolio for final evaluation by the concerned faculty.</td><td></td></tr>
<tr><td>Unit-II</td><td colspan="2">Building Energy Modeling and Passive Design simulation</td><td>30 hrs</td></tr>
<tr><td></td><td colspan="2">Introduction to environmental performance assessment and use of scientific tools and simulation software’s for assessment of thermal and lighting processes in built forms and outdoor spaces. Building simulations for analysis of sustainable designs, software’s for</td><td></td></tr>
</table>

	simulation of passive building design and real time daylight calculations	

IA: Please refer to the guidelines given in the annexure

Sessional work

1. A report containing data collection, climate analysis , calculations and case studies, etc.
2. A1/A2 size portfolio explaining the complete design scheme

Text Books and References

- Man climate and architecture – *B. Givoni, Applied science pub. Ltd., U.K.*
- Manual of tropical housing and building – *Koenigsberger et al, Orient Longman, 1973.*
- Climate Design: Energy Efficient building principles and practices by *Watson Donalt*
- Climate responsive architecture- a design handbook for energy efficient buildings, *Tata McGraw-hill Publishing Company Limited -2000*
- Sun, Wind & Light – *G.Z. Brown, Mark Dekay, John Wiley & Sons, 2001.*

Energy Conservation I (Thermal Environment)

Subject Code : SA 104			
Teaching Scheme		**Examination Scheme**	
Teaching	6 hours/week	Credits	6
Teaching hours/ semester	90 hours	University examination (UE)	60 marks
Hours for Internal Assessment	18 hours	Internal Assessment (IA)	40 marks

Aim:
Demonstrate knowledge and understanding the effects of thermal environment (climate) on comfort condition in built spaces.

Learning Outcome :
At the end of semester the student will understand:

- Climate parameters, climates zones and thermal comfort parameters
- Building physics and thermal comfort
- Building design and solar passive techniques

Unit I	**Introduction to Thermal Environment**	6 hours
	Introduction to need of Passive design and energy conservation. Introduction to climate and its elements Characteristics of Various climate zones Physics of Heat transfer in Buildings-Thermal Quantities, Heat exchange of Buildings, Periodic Heat Flow Thermal comfort factors	
Unit-II	**Climate and buildings : Analysis techniques**	18 hours
	Climate as a context : sun, wind, sun and wind, light, and comfort.	
Unit III	**Analysis Techniques to understand thermal behavior of buildings: Building Program and use, Building form and Envelope**	18 hours
	Building program and use : occupancy heat gain, electric lighting heat gain, equipment heat gain *Form and envelope:* skin heat flow, window solar gain, ventilation/ infiltration gains and losses *Combining Climate, program and form:* Building bioclimatic chart, Shading calendar, Total heat gains and losses, balance point temperatures and balance point profiles.	
Unit IV	**Thermal Design Strategies at Site, Building Scale and Component Scale**	24 hours
	Analysis, selection, formulation and evaluation of thermal design strategies at various scales.	
Unit V	**Strategies by Climate type and Energy Intentions.**	18 hours
	Design decisions: Making strategy bundles for neighborhoods, buildings and rooms. *Combined bundles:* single topical issues (heating, cooling, lighting, ventilation or energy) Multiple integrated topical issues (heating, cooling, lighting,	

	ventilation or energy liked across various scales)	
Unit VI	**High performance Buildings**	6 hours
	Net zero and peak zero buildings , net positive buildings, carbon neutral buildings etc.	
Sessional Work: Unit tests and assignments based on contents above		
IA: Please refer to the guidelines given in the annexure		
Text Books and References		

- Sun, Wind & Light – G.Z. Brown, Mark Dekay, John Wiley & Sons, 2001. (Second edition)
- Sun, Wind & Light – G.Z. Brown, Mark Dekay, John Wiley & Sons, 2001. (Third edition)
- Inside out – G. Z. Brown et al, John Wiley and Sons, 1992.
- Man climate and architecture – B. Givoni, Applied science pub. Ltd., U.K.
- Manual of tropical housing and building – Koenigsberger et al, Orient Longman, 1973.
- Mechanical and electrical equipment for building – Stein, Benjamin and Reynolds, John Wiley and Sons, 1991.
- Energy efficient buildings in India – Milli Mujumdar, TERI, MONES, 2001.
- Managing energy efficiently in hotels and commercial buildings – Pradeep kumar, Amitkumar Tyagi, TERI, New Delhi, 2002.
- Energy Conservation Building Code, Bureau of Energy Efficiency
- Introduction to Architectural Science-the basis of sustainable design— Steven.V.Szololay, published by Elsevier 2008
- Climate responsive architecture- a design handbook for energy efficient buildings, Tata McGraw-hill Publishing Company Limited -2000

Sustainable Materials and Technology

Subject Code : SA 105			
Teaching Scheme		**Examination Scheme**	
Teaching	4 hours/week	Credits	4
Teaching hours/ semester	60 hours	University examination (UE)	60 marks
Hours for Internal Assessment	12 hours	Internal Assessment (IA)	40 marks

Aim:
To study various contemporary and traditional materials, assess their performance and methods of sustainable construction for energy efficiency

Learning Outcome :
At the end of semester the student will understand:

- Significance of contemporary and traditional materials in buildings
- Characteristics of specific materials and their sustainably managed alternatives
- Traditional and advanced efficient building techniques.

Unit I	**Introduction to sustainable materials**	6 hours
	Environmental impact of building materials, Materials-related impacts of sustainable building materials, examples of "green" materials, issues related to "sustainable" materials, future of "sustainable" materials, characteristics of sustainable materials and energy efficiency in materials.	
Unit-II	**Life cycle analysis and Life cycle cost analysis**	6 hours
	Introduction of LCA and LCC, embodied energy of materials, material life cycle, process of calculation and relevance in sustainable building material selection and construction techniques , Eco Labeling of Materials	
Unit III	**Traditional Building Materials**	12 hours
	Application, treatment and implementation of various materials like soil identification and testing, stabilized soil blocks, rammed earth, cob and adobe , bamboo , stabilized earth blocks etc. Traditional materials for interior	
Unit IV	**Contemporary Building Materials**	12 hours
	Application, treatment and implementation of various materials like fly ash blocks and bricks ferrocement, ferrocrete, glass, insulation, steel structures, building materials from solid wastes, recycled materials, gypsum, eco-boards etc. Contemporary materials for interior	
Unit V	**Sustainable Construction Technologies - Traditional**	
	Walling , flooring and Roofing techniques; composite walls, rammed earth walls, hollow block constructions, cavity walls, masonry domes vaults and arches, bamboo wall and roof construction, thatch & mud plaster etc. Traditional technologies for Interior Design	12 hours

Unit VI	**Sustainable Construction Technologies – Contemporary**	12 hours
	Advanced walling , flooring and roofing techniques; pre-Stressed and pre- cast construction, Pre-fabrication and Modular etc, precast waffle construction, precast hollow planks for flooring and roofing elements etc.)	
Sessional Work: Unit tests and assignments based on contents above		
IA: Please refer to the guidelines given in the annexure		
Text Books and References		

- Green Building Materials; *Ross Spiegel and Dru Meadows*
- Sustainable building technical manual: Green building design, construction and operations, Abraham L.E. et al, 1996, Washington D.C. U.S. Green building council and Public Technology, Inc.
- Earth Construction, *Houben Hugo*
- Directory of Indian building materials, BMTPC, 2003, LHM publication
- National building code of India, BOS, Govt. of India, 2001
- Energy Efficient Buildings in India by Milli Mujumdar
- Green Architecture, Design for a sustainable future
- Energy efficient buildings by Wagner Walter
- Architecture, Engineering and Environment by Hawkes Dean and Foster Wayne
- Publications from - CBRI - Roorkee
    - IDC - Mumbai
- - NID - Ahmedabad

Elective I

Subject Code : SA 106			
Teaching Scheme		**Examination Scheme**	
Contact Hours	2 hours/week	Credits	2
Contact hours/ semester	30 hours	University examination (UE)	-
Hours for Internal Assessment	6 hours	Internal Assessment (IA)	100 marks

Aim:

To facilitate the students to learn out of a pool of specialized subjects, which provides extended scope or which enables exposure to discipline-centric' subjects as well as cross-disciplinary subjects.

Learning Outcome :

At the end of semester the student will understand:

- Application of knowledge in solving a real life problem in an analytical and scientific way.

Description

The student can select any one subject in semester I from the list of subjects prepared by the department. A comprehensive list of subjects to be included under three broad areas of study namely; Core, Allied and Open Electives

A selected subject expertise be arranged to provide for necessary syllabus formulation and guidance to students.

Sessional work :

The students are expected to study the selected topic in depth under the guidance of the expertise, undertake case-studies and necessary site visits, and collect all the relevant information and present an exhaustive study report in a group.

IA: Please refer to the guidelines given in the annexure

Green Building Assessment & Certification

Subject Code : SA 201			
Teaching Scheme		**Examination Scheme**	
Teaching	4 hours/week	Credits	4
Teaching hours/ semester	60 hours	University examination (UE)	60 marks
Hours for Internal Assessment	12 hours	Internal Assessment (IA)	40 marks

Aim: To acquaint students with different Green Building Rating Systems prevailing in India namely GRIHA, LEED – IGBC and codes.		
Learning Outcome : At the end of semester the student will understand: • Established practices and emerging concepts in green buildings • Various evaluation and assessment systems		
Unit I	**Introduction to green rating systems**	8 hours
	Objectives and characteristics of National & International rating systems, facilitation and simulation for green rating systems , assessment criteria's for green rating, process of certification. Time line of GBRS	
Unit II	**Green Rating for Integrated Habitat Assessment**	16 hours
	Introduction to GRIHA, Role of GRIHA in recognizing environment-friendly initiatives, Concept of Green Buildings. GRIHA- National Green Building Rating System- its context, challenges, benefits, development and operation process and basic features. Process of rating buildings- registration and documentation, GRIHA evaluation process Criteria for rating in detail and Scoring points for GRIHA	
Unit III	**Leadership in Energy and Environmental Design**	16 hours
	LEED Green Building Rating System- Introduction, History of LEED, Features of LEED Introduction to USGBC LEED USGBC – Vision of USGBC, USGBC Structure and Services offered, USGBC rating systems focus areas, rating systems for different types of Buildings, registration and certification process, details of credits, process to achieve rating. LEED NC overview and process- use of LEED NC, Registration, Credit Interpretation Ruling, Application, Review and Certification. LEED IGBC – Vision of IGBC, IGBC Structure and Services offered, IGBC rating systems focus areas, rating systems for different types of Buildings, registration and certification process, details of credits, process to achieve rating.	

Unit IV	**Design Base Green Rating System**	8 Hours
	Process of rating buildings- registration and documentation, IGBC evaluation process Criteria for rating in detail and Scoring points for IGBC Compliance of IGBC rating system for any building typology (Ongoing actual Project).	
Unit V	**Introduction to other green rating systems**	6 Hours
	BRE Environmental Assessment Method (BREEAM) BREEAM, drivers and users of BREEAM, Key Benefits of Users, Different Stages of BREEAM, BREEAM Criteria, Environmental Issues, History of BREEAM, Current Versions of BREEAM, Certification Process. Green Globe Systems- Canada, Green Star (Australia)	
Unit VI	**Standards and Codes for green rating systems**	6 Hours
	ASHRAE and ISHRAE Codes, ECBC 2017 ECBC compliance and approach, Compliance requirements, compliance documents, calculation of energy consumption of proposed and standard design, whole building compliance method	
Sessional Work: Unit tests and assignments based on contents above		
IA: Please refer to the guidelines given in the annexure		
Text Books and References		

- Relevant Code Books for ASHRAE and ISHRAE
- National Building Code India
- National rating system (GRIHA) – GRIHA Manual I
- LEED IGBC Reference Guide: LEED-INDIA-NC Abridged Version 1.0
- BREEAM New Construction, Non-domestic buildings, Technical Manual SD5073- 2.0:2011
- GREEN GLOBES FOR NEW CONSTRUCTION-Technical Reference Manual-Version 1.3 February 19th, 2014

Energy Systems and Utilities

Subject Code : SA 202			
Teaching Scheme		**Examination Scheme**	
Teaching	4 hours/week	Credits	4
Teaching hours/ semester	60 hours	University examination (UE)	60 marks
Hours for Internal Assessment	12 hours	Internal Assessment (IA)	40 marks

Aim: To make students aware about different aspects of Thermal & Electrical Utility Systems**.**		
Learning Outcome : At the end of semester the student will understand: • Application of thermal systems in building industry and Energy Conservation Opportunities. • Application of electrical systems in building industry and Energy Conservation Opportunities. • HVAC systems and their types, their application and Energy Conservation Opportunities		
Unit I	**Fuels and Combustion**	6 hours
	Introduction to Fuels, Properties of Liquid Fuels, Properties of Coal, Properties of Gaseous fuels, Properties of Agro Residues, Combustion Process – Principles and Three “T”s of combustion, Draft systems, Combustion controls.	
Unit-II	**Boilers and Steam Systems**	6 hours
	Boiler Specification, Indian Boiler Regulation, Boiler systems, Boiler types and Classification, , Boiler Performance Evaluation – Direct & Indirect methods, Energy Conservation Opportunities and Waste Heat Recovery Systems in Boilers. Properties of Steam, Steam distribution system, Efficient Steam Utilization, Benefits of Condensate Recovery, Insulation of Steam Pipelines and Hot Process Equipment, Energy Efficient Steam Utilization and Energy Saving Opportunities	
Unit III	**Insulation**	4 hours
	Purpose of Insulation, Insulation - Types and Application, Economic thickness of insulation, Hot and Cold Insulation. Introduction to Waste heat recovery process, Classification of Waste heat recovery and Application, Benefits of Waste heat recovery.	
Unit IV	**Electrical Systems and Major Electrical Equipment**	20 hours
	Introduction to Electrical Power Supply Systems - Generation, Transmission, Transmission & Distribution System losses and Efficiency, Industrial Consumer and Typical Industrial Distribution System, Electricity billing, Concept of Maximum Demand, Electrical load management and Maximum Demand Control, Power factor Improvement and benefits, Automatic Power Factor Controller**,** Distribution losses in Industrial systems and reduction in Losses.	

	Types of Transformers, Transformer Rating, Location, Transformer Efficiency and Losses, Efficient Operation of Transformers and Labeling. Types of Electric Motor Characteristics and Efficiency, Energy Efficient Motors, Motor load survey, Star Labeling of Energy Efficient Motors, Energy Conservation in Motors Types of Fans in Buildings, Energy Efficient Ceiling Fans and Labeling of Roof top Turbo Ventilators. Calculation of number of Turbo Ventilators for Built Spaces. Pumps for Buildings, Characteristics of Pumps, System Characteristics of Pumps, Energy Savings in Pump Operation, Level Controller, Energy Efficient Pumps and Star Labeling	
Unit V	**Air Conditioning & Refrigeration Systems and Cooling Towers**	20 hours
	Introduction, Types of Refrigeration systems, Vapor Compression, Vapour Absorption System, Radiant Cooling Systems, Solar Air Conditioning Systems, Commonly used Refrigerants, Compressor Types and Applications, Selection of Refrigeration system. Energy Efficiency Ratio, COP, Performance assessment, Factors affecting Performance and Energy Efficiency of AC / Refrigeration Plants, Standards and Energy Labeling of Room Air Conditioners, Energy Saving Opportunities. Cooling tower introduction, Types of Cooling Towers,, Components of Cooling Tower & materials, Cooling Tower Performance, Energy Conservation Opportunities	
Unit VI	**Energy Conservation Building Code (ECBC-2007 and 2017)**	4 hours
	ECBC for Building Utilities ,HVAC, Service Water, Lighting And Electric Power & Motors **Building Utilities** HVAC – Mandatory Requirements – Natural Ventilation, Minimum Equipment Efficiencies, Controls, and Piping and Ductwork, System balancing, Condensers, Economizers, Variable Flow Hydronic Systems Service Hot Water & Pumping – Mandatory Requirements – Solar Water Heating, Equipment Efficiency, Supplementary Water Heating Systems, Piping Insulation, Heat Traps, Swimming Pools, Compliance requirements Lighting – Mandatory Requirements for Lighting control, Exterior Lighting Power Calculations by Building Area Method and Space Function Method, Exterior Lighting Power Electric Power – Mandatory Requirement for Transformers, Energy Efficient Motors, Power Factor Correction , Check Metering and Power distribution system losses	
Sessional Work: Unit tests and assignments based on contents above		
IA: Please refer to the guidelines given in the annexure		
Text Books and References		

Energy Conservation Building Code – 2017 Document Issued by Bureau of Energy Efficiency, New Delhi

Boilers and Fuels:

- Combustion Engineering and Fuel Technology – Oxford and IBH publishing Co. – A. K. Saha.
- Web sites – www.pcra.org .
- Efficient Operation of Boilers – NPC.
- Web sites – www.eren.doe.gov , www.oit.doe.gov/bestpractices

Steam Systems:

- Improving Steam System Performance – A Source book for Industry by Office of Industrial Technologies, Energy Efficiency and renewable Energy, U.S. Department of Energy.
- Web sites - www.iclei.org , www.pcra.org
  www.armstrong-intl.com
  www.engineeringtoolbox.com

Insulation and Waste Heat Recovery:

- Thermal Insulation And Refractories – PCRA
- Web Sites - www.pcra.org
- Heat recovery systems – D. A. Reay, E. and F. N. Span, London 1979

Electrical

- Technology menu on energy efficiency – NPC.
- NPC – In house case studies.
- Electrical energy conservation modules of AIP – NPC, Chennai.
- Managing energy efficiently in hotels and commercial buildings – Pradeep
- Kumar, Amitkumar Tyagi, TERI, New Delhi, 2002.
- Technology Menu for Energy Efficiency – NPC.
- ASHRAE Handbook.

Sustainable Design Studio-II

Subject Code : SA 203			
Teaching Scheme		**Examination Scheme**	
Teaching	10 hours/week	Credits	10
Teaching hours/ semester	150 hours	University examination (UE)	60 marks
Hours for Internal Assessment	30 hours	Internal Assessment (IA)	40 marks

Aim :
To translate sustainable design principles into with the Application Procedure of relevant Analysis Techniques, Design Strategies and Evaluation Procedures for Thermal and Luminous Environment, into Architectural Design Problem and application of environmental modeling and simulation tools and techniques to building design.

Learning Outcome:
At the end of the semester the student will be able review different approaches of thermal and lighting design in buildings.

Unit I	**Studio :Project Description**	8 hrs/week
	A large scale project of area from 5000 -20,000 sq.m. built up to respond to Thermal and Luminous Environments using scientific methods of design namely analysis techniques, design strategies and system integration and evaluation procedures. An area up to 5000sq.m of the same project could be taken as a small project for detail lighting design. The project sites should be selected by the students having different orientations, ground conditions, urban infrastructure and vegetation along with a set of six different climates of the Indian sub-continent. Students shall also perform Energy Simulation, day lighting and artificial lighting exercise for their design solution using energy simulation software e. g. Ecotect , radiance or similar. Design Methodology: 1. Completion of data collection related to climate, site and day lighting 2. Analysis of the building Programme and use for thermal and luminous environment. 3. Data base & data processing, analysis, projection & graphic presentation of climate, site and day lighting 4. Formulating Approach / parameters for proposed design / plan / model – Schematic Design 5. Design / plan / model proposals and details 6. Implementation/application thermal and lighting	

	calculations both manual and simulation 7. Evaluation, conclusion including cost - benefit appraisal for relevance of the work.	
Unit-II	**Building Energy Modeling and lighting simulation**	2 hrs/week
	Introduction to environmental performance assessment and use of scientific tools and simulation software's for assessment of lighting processes in built forms and outdoor spaces. Building simulations for analysis of sustainable designs, software's for simulation of day lighting, artificial lighting and real time daylight calculations	

Sessional work

1. A report containing data collection, climate analysis , calculations and case studies,etc
2. A1/A2 size portfolio explaining the complete design scheme

IA: Please refer to the guidelines given in the annexure

Text Books and References

- Man climate and architecture – *B. Givoni, Applied science pub. Ltd., U.K.*
- Manual of tropical housing and building – *Koenigsberger et al, Orient Longman, 1973.*
- Climate Design: Energy Efficient building principles and practices by *Watson Donalt*
- Climate responsive architecture- a design handbook for energy efficient buildings, *Tata McGraw-hill Publishing Company Limited -2000*
- Sun, Wind & Light – *G.Z. Brown, Mark Dekay, John Wiley & Sons, 2001.*

Energy Conservation II (Luminous Environment)

Subject Code : 204			
Teaching Scheme		**Examination Scheme**	
Teaching	6 hours/week	Credits	6
Teaching hours/ semester	90 hours	University examination (UE)	60 marks
Hours for Internal Assessment	18 hours	Internal Assessment (IA)	40 marks

Aim:
Demonstrate knowledge and understanding the effects of Luminous Environment on comfort condition in built space.

Learning Objective :
At the end of semester the student will understand:

- Phenomenon of Light and the Day-lighting strategies
- Less energy-intensive technologies for artificial lighting
- Artificial lighting performance and savings from day-lighting

Unit I	**Introduction to Luminous Environment**	2 hours
Unit-II	**Lighting Fundamentals**	18 hours
	Physics of light, Light and sight, Quantity of Light, Quality of Light, Fundamentals of Colour.	
Unit III	**Analysis Techniques, Design Strategies and Evaluation Procedures – Luminous Environment**	10 hours
	Analysis of the Precedent, Analysis of the site and climate, Analysis of the building Programme and use, Schematic design, Design development and System integration. Glazing Properties, Design Options of top lighting/side lighting/Core Daylighting/Atrium	
Unit IV	**Light Sources and Lighting Design Process**	16 hours
	Daylight sources, electric light sources	
Unit V	**Day lighting Design and Electrical Lighting Design**	24 hours
	Day lighting opportunities, Strategies for day lighting buildings, Aperture Sizing- side lighting and top lighting, specialized day lighting strategies, daylight factor, components of day lighting, guidelines for preliminary day lighting design, design analysis method and physical modeling. Luminaires, lighting control, Detailed Design procedures, evaluation.	
Unit VI	**Electrical Lighting Applications**	20 hours
	Residential occupancies, educational facilities, Commercial Interiors , industrial lighting and special lighting applications.	

Sessional Work: Unit tests and assignments based on contents above

IA: Please refer to the guidelines given in the annexure

Text Books and References

- Sun, Wind & Light – G.Z. Brown, Mark Dekay, John Wiley & Sons, 2001.
- Inside out – G. Z. Brown et al, John Wiley and Sons, 1992.
- Man climate and architecture – B. Givoni, Applied science pub. Ltd., U.K.
- Manual of tropical housing and building – Koenigsberger et al, Orient
- Longman, 1973.
- Mechanical and electrical equipment for building – Stein, Benjamin and
- Reynolds, John Wiley and Sons, 1991.
- Energy efficient buildings in India – Milli Mujumdar, TERI, MONES, 2001.
- Managing energy efficiently in hotels and commercial buildings – Pradeep Kumar, Amitkumar Tyagi, TERI, New Delhi, 2002.

Research Design and Methods

Subject Code : SA 205			
Teaching Scheme		**Examination Scheme**	
Teaching	4 hours/week	Credits	4
Teaching hours/ semester	60 hours	University examination (UE)	60 marks
Hours for Internal Assessment	12 hours	Internal Assessment (IA)	40 marks

Aim:
To induce research attitude in students by introducing them to research methodology with a focus on sustainable architecture.

Learning Outcome :
At the end of semester the student will understand:

- Significance, types, approaches and areas of research in sustainable architecture
- To Conduct research and prepare report

Unit I	**Introduction to research methodology**	04 hours
	• Meaning, need and significance of research. • Objectives and characteristics of research • Criteria for good research • Areas of research in sustainable architecture. • Ethics in research	
Unit-II	**Introduction to research types and approaches**	10 hours
	• **Research Types** ▪ Historic, Descriptive, Case study, Experimental, Applied and Causal, etc. ▪ Advantages and disadvantages of various research types • **Research Approaches** ▪ Qualitative ▪ Quantitative ▪ Mixed ▪ Advantages and disadvantages of various approaches	
Unit III	**Research Design**	16 hours
	• **Steps in conducting research** ▪ Preparing Research Proposal ▪ Formulating research problem ▪ Framing Hypothesis and understanding variables ▪ Literature review and sources for literature • **Sampling design** ▪ Need for sampling ▪ Types of sampling design ▪ Criteria for sample selections	

Unit IV	**Data collection**	08 hours
	• Types of data • Tools for data collection (Survey, observation, interview, mapping, etc) • Measures of central tendencies (mode, mean, median) • Measurement and scaling techniques	
Unit V	**Data presentation and analysis**	14hours
	• Data presentation techniques • Introduction to analytical tools (Descriptive statistics, content analysis, visual analysis) • Interpreting results	
Unit VI	**Research Report**	08hours
	• Structure of report • Writing report and presentation • Referencing styles	
Sessional work: Unit tests and assignments based on above content		
IA: Please refer to the guidelines given in the annexure		
Text Books and References		

- Kothari, C. R. (2004). *Research Methodology Methods & Techniques* (Second Edition ed.). New Delhi: New Age international publisher.
- Sanoff, H. (1991). *Visual Research Methods in Design*. NewYork: VNR.
- Bechtel, R., Marans, R., & Michelson, W. (Eds.). (1990). *Methods in environmental and behavioral research* (second ed.). Florida: Robert E. Krieger
- Groat, L., & Wang, D. (Eds.). (2002). *Architectural Research Methods*: John Wiley and Son.
- Zeisel, J. (2006). *Inquiry by Design* (Revised ed.). New York W.W.Nortan & Company

Elective II

Subject Code : SA 206			
Teaching Scheme		**Examination Scheme**	
Contact Hours	2 hours/week	Credits	2
Contact hours/ semester	30 hours	University examination (UE)	-
Hours for Internal Assessment	6 hours	Internal Assessment (IA)	100 marks

Aim:
To facilitate the students to learn out of a pool of specialized subjects, which provides extended scope or which enables exposure to discipline-centric' subjects as well as cross-disciplinary subjects.

Learning Outcome :
At the end of semester the student will understand:

- Application of knowledge in solving a real life problem in an analytical and scientific way.

Description
The student can select any one subject in semester II from the list of subjects prepared by the department. A comprehensive list of subjects to be included under three broad areas of study namely; ; Core, Allied and Open Electives.
A selected subject expertise be arranged to provide for necessary syllabus formulation and guidance to students.

Sessional work :
The students are expected to study the selected topic in depth under the guidance of the expertise, undertake case-studies and necessary site visits, and collect all the relevant information and present an exhaustive study report in group.

IA: Please refer to the guidelines given in the annexure

Advanced Simulation Modeling

Subject Code : SA 301			
Teaching Scheme		**Examination Scheme**	
Teaching	4 hours/week	Credits	4
Teaching hours/ semester	60 hours	University examination (UE)	60 marks
Hours for Internal Assessment	12 hours	Internal Assessment (IA)	40 marks

Aim: To introduce software simulation tools for energy efficient buildings.		
Learning Outcome : At the end of semester the student will understand: • Environmental modeling and simulation of built and open spaces.		
Unit I	**Introduction to simulation tools**	8 hours
	Introduction to advanced tools for thermal, air flow and lighting simulation and their application to building design and design research.	
Unit-II	**Performances Assessment and Inference**	
	Environmental software's will be introduced for assessment and representation of thermal, airflow, lighting processes and energy simulation in and around a real or virtual building and outdoor spaces. The course will allow the students to generate and analyze climate data for any site, predict micro-climate conditions, perform shading, day lighting and thermal simulation studies, calculate energy requirements and assess environmental impacts of building.	Module based distribution of teaching hours.
Sessional work		
	Students have to model and simulate a design project with a detailed report of inferences and solutions drawn from the simulation study.	
IA: Please refer to the guidelines given in the annexure		

Clean Technologies

Subject Code : SA 302			
Teaching Scheme		**Examination Scheme**	
Teaching	4 hours/week	Credits	4
Teaching hours/ semester	60 hours	University examination (UE)	60 marks
Hours for Internal Assessment	12 hours	Internal Assessment (IA)	40 marks
Aim: To introduce students to Fundamentals and Technologies of different Clean Technologies.			
Learning Outcome : At the end of semester the student will understand: • Different types of Alternate or Renewable Energy Sources. • Developments in the field of clean technologies in India and abroad.. • Their application and Energy Conservation Opportunities			
Unit I	**Concept of Clean Technologies and Renewable Energy Sector Scenario in India and World**		6 hours
	Concept of Clean Technologies, Introduction to New & Renewable Sources, Types and Classification of Renewable Energy Sources, Need for Promoting Rapid Growth of New and Renewable energy in India, Benefits and Limitations on Use of Renewable Energy, Overview of Renewable Energy Development in the World over last few Years, Issues and Challenges for Growth of Renewable Energy at in India and at Global level		
Unit-II	**Fundamentals of Renewable Energy Technologies, Status of Technological Developments and Capacity Growth in India**		8 hours
	Principles and Fundamentals of Different types of Renewable Energy Sources, Status of Technologies and Technological Development of different Renewable Energy Sources in India. Present Status of Sector wise Renewable Energy Capacity Development in India, Potential & Future Scope for Renewable Energy Capacity Development in the Country, Targets for RE Development in the Country, Rural Renewable Energy Renewable Energy Policies, Present Incentives & Subsidies		
Unit III	**Solar Thermal Energy and Solar Electrical Energy Systems**		20 hours
	Fundamentals of Solar Energy, Solar Heating and Solar Power, Flat Plate Collector Technology, Evacuated Tube Collectors Technology, Solar Concentrators for Steam Generation, Solar Water Heating Systems for Commercial, Residential and Industrial Sectors, Thermal Storage Systems Jawaharlal Nehru National Solar Mission, Solar Energy Systems for Buildings, Sizing ,Selection Criteria and Feasibility. Solar Air Conditioning.		
Unit IV	**Wind Energy**		12 hours
	Basics of Wind Energy and Wind Power Generation, Variability of Wind Speed and its Effect, Types of Wind Turbines, Operating Characteristics of Wind Turbines and Generators, Wind energy		

	Calculations, Capacity factor, Grid connected Wind Generators, Future of Wind power Generation in India, Issues related to Wind power Generation, Small size Wind Energy Systems for Buildings, Selection Criteria and Feasibility	
Unit V	**Hydro Power, Bio-Energy, Oceanographic and Geothermal Energy**	8 hours
	Basics of Hydro power generation, Classification of Hydro power Plants, Future of Growth of Hydro power capacity increase in India Fundamentals of Bio-energy, Bio-mass, Biogas and Bio-fuels, Direct combustion of Biomass, Biomass Gasification, Bio- methanation, Bio-fuels from biomass, Installed Biomass Power Capacity, Growth of Ethanol & Bio-fuel Production Fundamentals of Wave, Tidal Energy and Ocean Thermal Energy Conversion (OTEC), Basics of Geothermal Energy, Usages of Geothermal energy, Power Generation through Geothermal energy. Indian Scenario of Oceanographic and Geothermal Energy	
Unit VI	**Chemical Energy Sources and Energy from Solid and Liquid Wastes & Other Sources**	6 hours
	Principles of Fuel Cell Technology, Operation of Fuel Cells, Present Status and Future of Fuel Cell Development Hydrogen as efficient fuel, Principle of Waste to Energy Generation, Municipal Solid Waste Power Generation (MSW), Power Generation from Municipal Sewage and Effluents. Power Generation from Landfill Gas Principle of Magneto Hydro Dynamic Power Generation (MHD) Principle of Energy storage and Distribution, Batteries	
Sessional Work: Unit tests and assignments based on contents above		
IA: Please refer to the guidelines given in the annexure		
Text Books and References		

- Book 1 Published by Bureau of Energy Efficiency, New Delhi – Book -1.
- Alternate Energy Sources – T. H. Taylor, Adam Higlar Ltd., Bristol.
- Renewable Energy Sources for rural areas in Asia and Pacific- APO, Tokyo 2000.
- Energy Technology – S. Rao, Dr. B. B. Parulekar – Khanna Publications.
- Non-conventional Energy Sources – G. D. Rai – Khanna Publications.
- Websites – www.ireda.org, www.windenergy.com
- Kumar, Amitkumar Tyagi, TERI, New Delhi, 2002.
- Technology Menu for Energy Efficiency – NPC.
- ASHRAE Handbook.

Sustainable Design Studio-III

<table>
<tr><td colspan="4">Subject Code : SA 303</td></tr>
<tr><td colspan="2">Teaching Scheme</td><td colspan="2">Examination Scheme</td></tr>
<tr><td colspan="2">Teaching</td><td>10 hours/week</td><td>Credits</td><td>6</td></tr>
<tr><td colspan="2">Teaching hours/ semester</td><td>150 hours</td><td>University examination (UE)</td><td>60 marks</td></tr>
<tr><td colspan="2">Hours for Internal Assessment</td><td>30 hours</td><td>Internal Assessment (IA)</td><td>40 marks</td></tr>
<tr><td colspan="4">Aim:
To undertake detailed analysis of urban environmental issues related to sustainable planning and design of cities.</td></tr>
<tr><td colspan="4">Learning Outcome :
At the end of semester the student will understand:
• Various urban environmental issues and approaches to address them.</td></tr>
<tr><td>Unit I</td><td colspan="3">Studio: Project I 60 hrs</td></tr>
<tr><td></td><td colspan="3">The exercise will address the urban environmental issues. The exercise shall consist of a critical issue for understanding environmental challenges faced in urban context.
Design Methodology:
• Identify environmental issues related to selected urban areas.
• Study impact of these issues on selected area of the study.
• Study parallel cases to understand the approaches for addressing the issues.
• Provide guidelines and solutions for sustainable planning and designing of the study area.

The base work for the lab will be carried out in group and issues will be addressed individually.</td></tr>
<tr><td>Unit-II</td><td colspan="3">Studio: Project II 90 hrs</td></tr>
<tr><td></td><td colspan="3">A design Project of area from 3000-5000 sq.m. built up that reflects clear understanding of solar passive principles, luminous and acoustic response taught during the semester.</td></tr>
<tr><td colspan="4">Sessional Work
1. A well documented report for project I submitted by a group of students
2. A2 size portfolio giving design solution along with analysis for project II.</td></tr>
<tr><td colspan="4">IA: Please refer to the guidelines given in the annexure</td></tr>
<tr><td colspan="4">Text Books and References</td></tr>
</table>

- Man climate and architecture – *B. Givoni, Applied science pub. Ltd., U.K.*
- Manual of tropical housing and building – *Koenigsberger et al, Orient Longman, 1973.*
- Climate Design: Energy Efficient building principles and practices by *Watson Donalt*
- Climate responsive architecture- a design handbook for energy efficient buildings, *Tata McGraw-hill Publishing Company Limited -2000*
- Sun, Wind & Light – *G.Z. Brown, Mark Dekay, John Wiley & Sons, 2001.*

Energy Conservation III (Acoustics and Aqueous Environment)

Subject Code : **SA 304**			
Teaching Scheme		**Examination Scheme**	
Teaching	6 hours/week	Credits	6
Teaching hours/ semester	90 hours	University examination (UE)	60 marks
Hours for Internal Assessment	18 hours	Internal Assessment (IA)	40 marks

Aim:
Demonstrate knowledge and understanding the effects of Acoustic and Aqueous on comfort condition in built space.

Learning Outcome :
At the end of semester the student will understand:

- Acoustical consideration and response of various spaces.
- Concepts related to resource-oriented water conservancy
- Management, recycling and reuse of waste.

Unit I	**Introduction to Introduction to Acoustic and Aqueous Environment**	8 hours
	Introduction and Analysis of the Precedents - Acoustic and Aqueous Response Climate and Site Analysis ,Analysis of Building Programme and Use, Schematic Design and Design development	
Unit-II	**Fundamentals of Architectural Acoustics and Sound in Enclosed Spaces**	12 hours
	Sound Theory and Hearing Phenomenon, Noise Sound in enclosures, Absorption, Room Acoustics, Room Design, Sound Reinforcement Systems	
Unit III	**Building Noise Control**	16 hours
	Noise Reduction, Absorption, Sound Isolation, Airborne Sound, Speech Privacy, Structure Borne Sound, Mechanical System of Noise Control, STC and IIC Recommendations and criteria, Outdoor Acoustic Considerations.	
Unit IV	**Water Management**	20 hours
	Water in Architecture, Hydrologic Cycle, Basic Planning, Collection and storage, site Planning and Components. Management of the water cycle as a single system, Management of water supply, sanitation and drainage - social imperatives, environmental considerations and economic challenges, technological, options for water management, recycling, reuse, conservation and treatment Design for water conservation – building and products Designing building services – plumbing, drainage and sewerage for effective water reuse, recycling, and recharge Rain water harvesting techniques – Basic Concepts of artificial recharge methods.	
Unit V	**Efficient Waste Water Treatment and Solid Waste Management**	24 hours

	Water less toilets and urinals, Principals of Drainage, piping, fittings and accessories, Design of residential and large building waste piping, Onsite individual and multiple Building Sewage treatment, Large scale sewage treatment systems, recycling and gray water, storm water treatment. Introduction to Waste management, Municipal Solid Waste Management, Waste as a Resource, Energy from Waste.	
Unit VI	**Waste Management and Recycling**	10 hours
	Wastes generated by Human Habitat – Solid, liquid and Gaseous Types of Wastes- Municipal, Industrial, Agricultural, Toxic, Bio-Medical, Hazardous, Electronic, Radioactive etc., Overview of laws /rules governing waste management in India , Importance of Community participation in waste management Impact on health and sanitation	
Sessional Work: Unit tests and assignments based on contents above		
IA: Please refer to the guidelines given in the annexure		
Text Books and References		

- Inside out – G. Z. Brown et al – John Wiley & sons Inc., New York.
- Environmental systems – H. J. Cowan, P. R. Smith, VNR Co., New York.
- Environmental Acoustics – Leslie L. Doelle, Canada.
- Architectural Acoustics – Eagan, M. David, McGraw Hill Co., 1988.
- MEEB – Stain, Benjamin et al, John Wiley & sons Inc. 2000.
- Sun, Wind & Light, Second edition, G. Z. Brown & Mark DeKay, John Wiley & sons
- Sustainable building technical manual: Green building design, construction and operations, Abraham L.E. et al, 1996, Washington D.C. U.S. Green building council and Public Technology, Inc.
- Composting and Vermi-composting, Agarwal S. K. and Saxena L.M. 2001.
- Watershed protection, Athens L and Ferguson B.K. 1996
- Climatic zones and rural housing in India, Bansal N. K. and Minke G. 1988
- Directory of Indian building materials, BMTPC, 2003, LHM publication
- CPCB publication, 1989 and 2000 on air quality and root zone method
- Beyond growth: The economics of sustainable development, Daly H. E. , 1997, Boston, Deacon press
- Energy recovery from Municipal solid waste: Potential and possibility, Dhussa A.K. and Varshney A.K., 2000, Bio-Energy news 4(1)

Dissertation I

Subject Code : SA 305			
Teaching Scheme		**Examination Scheme**	
Teaching	4 hours/week	Credits	4
Teaching hours/ semester	60 hours	University examination (UE)	60 marks
Hours for Internal Assessment	12 hours	Internal Assessment (IA)	40 marks

Aim: To apply the methods taught in **research design & methods** to carry out research related to the field of Sustainable Architecture. This will help in developing research skills in terms of selecting appropriate method to carry out research and writing report.

Learning Outcome :

At the end of semester the student will be equipped :

- To carry research work individually using selected approach and prepare report.

Unit I	Identify area of research related to sustainable architecture & prepare a proposal Design complete research including selecting methods for data collection, tool for Analysis etc.	8 hours
Unit-II	To carry out literature review and case studies	12 hours
Unit III	To Carry out research (Field work)	12 hours
Unit IV	To Compile and analyze collected data using tools.	8 hours
Unit V	Present analysis & draw conclusions	8 hours
Unit VI	To prepare a detailed research report and write a paper for publication	12 hours

Sessional Work: A research report of not more than 50 pages or a paper of approx. 3000 words on the selected area of research.

IA: Please refer to the guidelines given in the annexure

Text Books and References

- Kothari, C. R. (2004). *Research Methodology Methods & Techniques* (Second Edition). New Delhi: New Age international publisher.
- Sanoff, H. (1991). *Visual Research Methods in Design*. NewYork: VNR.
- Bechtel, R., Marans, R., & Michelson, W. (Eds.). (1990). *Methods in environmental and behavioral research* (second ed.). Florida: Robert E. Krieger
- Groat, L., & Wang, D. (Eds.). (2002). *Architectural Research Methods*: John Wiley and Son.
- Yvonne N. B. (2013). *How to Write a Master's Thesis* (Second edition). Sage publications Inc.

Elective III

Subject Code : SA 306			
Teaching Scheme		**Examination Scheme**	
Contact Hours	2 hours/week	Credits	2
Contact hours/ semester	30 hours	University examination (UE)	-
Hours for Internal Assessment	6 hours	Internal Assessment (IA)	100 marks

Aim:
To facilitate the students to learn out of a pool of specialized subjects, which provides extended scope or which enables exposure to discipline-centric' subjects as well as cross-disciplinary subjects.

Learning Outcome :
At the end of semester the student will understand:

- Application of knowledge in solving a real life problem in an analytical and scientific way.

Description
The student can select any one subject in semester III from the list of subjects prepared by the department. A comprehensive list of subjects to be included under three broad areas of study namely; ; Core, Allied and Open Electives.
A selected subject expertise be arranged to provide for necessary syllabus formulation and guidance to students.

Sessional work :
The students are expected to study the selected topic in depth under the guidance of the expertise, undertake case-studies and necessary site visits, and collect all the relevant information and present an exhaustive study report in a group.

IA: Please refer to the guidelines given in the annexure

Dissertation II

Subject Code : SA 401			
Teaching Scheme		**Examination Scheme**	
Contact Hours	18 hrs/week	Credits	18
Contact hours/ semester	270 hours	University examination (UE)	60 marks
Hours for Internal Assessment	18 hours	Internal Assessment (IA)	40 marks

Aim:
To integrate the acquired knowledge in the previous semesters into design solution.

Learning Outcome :
At the end of semester the student will demonstrate application of knowledge in solving a real life/difficult problem in an analytical and scientific way.

Description

The objective of design dissertation is to provide an opportunity to each student to undertake original and independent project in Semester IV on the subject area of his / her interest and specialization, developed through theory courses and architectural design projects of the previous semesters.
The quality of work should demonstrate student's ability to carry out successfully independent investigation, analysis and conclusions as well as evolve innovative design solution. The students will be guided in their work by appointed guides throughout the semesters to produce an illustrative, written dissertation.

Course Outline:
The subject selected may be conceptual or practical in nature related to a specific context and climate. The minimum built-up area shall not be less than 5000 sq.mtrs
M. Arch. Dissertations shall include :

- Selection of topic and preparing proposal
- Aim, Objectives and scope of work
- Methodology
- Literature Survey
- Data collection and Case Studies
- Findings/inferences/guidelines from literature survey and case studies
- Program formulation and analysis
- Site selection and analysis
- Selection of appropriate strategies and techniques
- Formulating Approach / parameters for proposed design
- Design solution and details
- Verification using simulation modeling

A progressive evaluation of the dissertation work done by the student will be made throughout semester by the departmental evaluation committee and concerned faculty

as per the schedule declared at the beginning of the term.
The final evaluation of the dissertation work and report will be done by the Dissertation Viva-Voce board at the end of the forth semester.

IA: Please refer to the guidelines given in the annexure

Sessional Work

1. Technical report:
   The entire work should be submitted in a comprehensive report as per prevailing norms and specifications.
2. Design Solution:
   A1 size portfolio explaining the complete design scheme with detailing and simulation results.

Self Study

Subject Code : SA 402			
Teaching Scheme		**Examination Scheme**	
Contact Hours	6 hours/week	Credits	4
Contact hours/ semester	60 hours	University examination (UE)	-
Hours for Internal Assessment	12 hours	Internal Assessment (IA)	100 marks
Aim: To facilitate the students to learn out of a pool of specialized subjects, which provides extended scope or which enables exposure to cross-disciplinary subjects.			
Description This subject is included in the syllabus to facilitate the students to learn cross-disciplinary subjects. Under this, the student can select any one subject related the parent course or other than the parent course. The choice of the subject is not restricted. If a student is interested in a subject of a particular discipline her/she has to inform accordingly to the Head and PG-Co-ordinator of that department.			
Sessional Work: A report on selected subject for study.			
IA: Please refer to the guidelines given in the annexure			

Seminar

Subject Code : SA 403			
Teaching Scheme		**Examination Scheme**	
Contact Hours	4 hours/week	Credits	4
Contact hours/ semester	60 hours	University examination (UE)	-
Hours for Internal Assessment	12 hours	Internal Assessment (IA)	100 marks

Aim:

The aim of the seminar is to train the students to prepare state of art report by assimilation of concepts / ideas on a chosen topic in the area of Sustainable Architecture through an extensive literature study and data collection from the field.

Description

The topic for seminar is to be selected on the specific aspects of Sustainable Architecture and a comprehensive seminar report is prepared with the identification of areas for further research and development.

The progress of the seminar work is presented and discussed by the student periodically in the classroom environment and progress monitored continuously. The seminar work develops the comprehension and presentation skills of the students.

Alternatively the students can also identify new topics for the seminar work which can be supportive literature study of their dissertation.

Sessional Work: Presentations and seminar report.

IA: Please refer to the guidelines given in the annexure

Internship

Subject Code : SA 404			
Teaching Scheme		**Examination Scheme**	
Duration	40 Working Days	Credits	4
		University examination (UE)	60 marks
		Internal Assessment (IA)	40 marks

Aim:

To give an opportunity for learning and for development of skills related to practical aspects of the discipline of Sustainable Architecture, by working in a firm/organization working in the field of Sustainability.

Description

The students will need to undertake internship of 40 working days to get acquainted with the procedures of the professional methods of consultancy.

The students will have to complete internship under a professional/institute/NGO registered with respective bodies working in the field of sustainable architecture/environment/energy/resource management or consultancy. Student can also work as a research associate with doctoral candidate/ institute.
During the course of their tenure, they will maintain a log book of their activities on a daily basis, which will be duly signed by the employer.

At the end internship the candidate will have to submit a training report along the certificate by the employer to the effect that he / she has completed training satisfactorily for the stipulated period.

Internal Assessment shall be done on the basis log book and training report which shall comprise of hard copies of the actual work done by the student, including reports on meetings attended, site visits performed and any work of special mention etc.