SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
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Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600 119
www.sathyabama.ac.in

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SCHOOL OF BUILDING & ENVIRONMENT

Department of Architecture

Board of Studies meeting for M.Arch. (Sustainabe Architecture) held on 01-07-2020

Venue: Virtual meet in ZOOM platform

Time: 10.30 AM – 1:00 PM

Members present:

External Members	Internal Members	Signature
Ar. ANUPAMA MOHANRAM, Co-Founder & Head - Architecture - Green Evolution Chennai	**DR. DEVYANI GANGOPHAHY** Dean & Head Department of Architecture School of Building & Environment	
Signature	**AR. ARULMALAR RAMRAJ** Associate Professor	
	AR. SHEETAL AMRAOTKAR Associate Professor	
	AR. SANGHAVI Associate Professor	

Special invitees present:

S.No	Name and Designation	Signature
1.	**AR. CATHERINE** Assistant Professor	
2.	**AR. KAVITHA** Assistant Professor	

The proposed curriculum and syllabus 2020 for M.Arch. (Sustainable Architecture) was accepted with the suggestions made by the external member as given below in the minutes of meeting

Minutes of the Board of Studies 2020 meeting

A Board of Studies meeting was held as Virtual mode in ZOOM platform on 1st July 2020 with the following agenda:

1. Welcome address, Opening remarks on the proposal to introduce REGULATION 2020 and the methodology adopted.
2. Comparative analysis of existing R 2015 and proposed R 2020 curriculum structure, R 2020 curriculum structure and Salient Features of Regulation 2020.

3. Detailed discussions on the proposed syllabus (from semester 1 to semester 4) and proposed Regulation 2020.
4. Any other matter with the permission of Chair.

At the onset, the Dean welcomed the members to the meeting of BOS and placed the agenda for deliberation of the members. The following deliberations were made as per the items of the agenda:

Dr. Devyani Gangopadhyay: explained the Retrospective outline of 2015 Regulations and scope for improvement. Then gave an overview about the concept for Regulation 2020 based on four focus areas being Energy conscious approach, Research Oriented, Flow of knowledge, User friendly and culturally responsive approach and how it is integrated with each semester was highlighted.

Followed by the Dean's initiation, the Syllabus Coordinator, Ar. Sheetal Amraotkar explained the following:

1. **Methodology** for framing the Syllabus which was based on inputs from the subject faculties, Students and the Professionals. The feedback consolidation from all were explained and this gave rise to the approach and requirements for broad changes in the curriculum. Further to this, comparative case study on five different syllabus was explained in brief, which enabled a cross verification with the current syllabus.
2. Ar. Sheetal Amraotkar then started explaining the subjects semester wise,

   In Semester I: Quantitative technique to be removed as it cannot be correlated without basic knowledge of Research methodologies instead it can be included in Semester 2 to quantify the research,

   Introduced new subject - SARA 5132 Building Energy & Environmental codes and standard, SARA 6131 Building Performance Analysis Studio I

   SARA 8201 Research Methodologies in Built Environment to be included as a core subject in the first semester to form the foundation for research approach.

   Semester II: SMTA5241 Quantitative Technique is been included which will be used to validate the research component.

   Elective component is not offered in first two semestersAr. Sheetal told, as we wanted to develop core competencies of the students in the initial semesters, to which Ar.Anupama completely agreed.
3. **In Semester III**: In regulation 2015, Design Studio III is been provided, now in regulation 2020 it is been removed and instead Dissertation is been introduced, to enhance the area of research and Elective I & Elective II was discussed
4. **In Semester IV**: EIA.Elective 3 and Thesis is been offered
5. Following Ar. Sheetal Amraotkar explanation, Ar.Anupama Mohanram appreciated the introduction of Building Performance Analysis Studio is great idea as it would keep the students up to date in new softwares,she also encouraged site visits for SARA 5133 Climate and Architecture in Tropics and EIA .
6. Followed by Ar,Anupama Mohanram', suggestion, Ar.Sheetal Amraotkar explained the Agenda II: The Conceptual Framework , Agenda III (A): Proposed changes to the curriculum in a nutshell & Agenda III (B):Semester wise discussion along with the credits

7. Ar, Anupama Mohanram enquired whether the Research Methodologies in Built Environment offered in Semester I is the basics of research, Ar Sheetal explained the various units in the subjects and it was accepted and appreciated by the expert.
8. ArAnupama Mohanram also appreciated the incorporation of Dissertation in Semester III as it would provoke the research interest among the students. She also insisted to be specific about the topic that needs to discussed in the built environment eg: Energy, water management etc.
9. Followed by ArAnupama Monhanram's Suggestions, Ar.Sanghavi explained the Subject SARA 5132 Building energy codes and Standards: where unit 1 & unit II covers the ECBC codes and unit III & unit IV discussed about SP14, which was also appreciated by the expert
10. Semester 1 subjects and studio were finalized by Ar. Anupama Mohanram
11. Followed by ArSanghavi' explanation ,Ar .Sheetal explained the Semester II subjects and the Studio in detail ,where she mentioned that the Design Studio would be divided into two projects, where the project 1: to be a medium sized project with all sustainable practices to be incorporated and Project 2: Retrofitting project
12. Followed by ArSheetal's explanation, Ar. Anupama suggested the project to be small, so the students can understand the various aspects of sustainability clearly and for the project 2: she said Retrofitting project was a good idea and can be picked anything within the campus. She said that the subjects and the studio's offered in semester II were fine.
13. Followed by Ar Anupamainputs, Ar Sheetal explained the Semester III Subjects, Electives, Training, Dissertation and Prethesis. ArAnupama asked to rethink of Elective: SARA 7333 Sustainable Building Practices as it looks generic and can be more focused and suggested to think of another elective or keep a case study itself as an elective, the students can identify the case study based on what aspect they wanted to do the study. This suggestion was cherished by the members in the meeting. Ar Sheetal suggested an open ended elective.
14. ArAnupama also suggested to have Green Building rating systems as core subject in Semester III instead of being offered as an Elective. The students can pick any rating system and address only the mandatory requirements to their particular project in Thesis, so that they learn sustainability in a holistic way.

    Ar. Sheetal conveyed that Green Building Rating Workshop was conducted in the semester where hands on calculations were given to students and they practiced simple calculations in the workshop. Ar. Anupama liked this concept.
15. Ar Anupama highlighted about the Practical training, since the time frame given for Practical training is limited to 30 days, she suggested the students go to site and learn as they can compare the material or even do a post occupancy study during their training period.
16. Ar Anupama advised that the Practical Training and the Dissertation can be linked.
17. Followed by Anupama Mohanram's Suggestion, Dean requested for consultancy projects, as the department is equipped with good climatology lab and their projects can be validated. Followed by Dean's request, ArAnupama agreed to look into the area of consultancy

18. Followed by ArAnupama's approval, Ar Sheetal explained about Semester IV Subjects, elective and Thesis and Environmental Impact Assessment is mandatory subject and that the new syllabus now included site visit also which was appreciated by ArAnupama.
19. Ar Sheetal explained the Thesis subject, which is culmination of all the Subjects, and Studio. Where the students can continue the Dissertation for their thesis o rless it can completely be a new topic.
20. Followed by Ar. Sheetal's explanation, Ar Anupama concluded that the curriculum was comprehensive and was pleased with the overall flow and subjects incorporated with just few corrections and appreciated the team for the process.
21. The meeting came to an end with Dean thanking note.

Minutes approved by

External Members	Signature
Ar. ANUPAMA MOHANRAM, Co-Founder & Head - Architecture - Green Evolution Chennai	

Internal Members	Signature
DR. DEVYANI GANGOPHAHY Dean & Head Department of Architecture School of Building & Environment	
AR. ARULMALAR RAMRAJ Associate Professor	
AR. SHEETAL AMRAOTKAR Associate Professor	
AR. SANGHAVI Associate Professor	

Note:

	The contents highlighted in yellow colour are newly added in the revised syllabus

SAR 5130	CONCEPTS AND PRINCIPLES OF SUSTAINABILITY	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To give a comprehensive introduction on the concepts of sustainability and the governing principles.
- To familiarize the implications of sustainability in various spheres such as social, economical, political and cultural.
- To explore the effective applications of sustainable approaches and principles in architecture.

UNIT 1 INTRODUCTION **8Hrs.**

Definitions of Sustainability- Various types of sustainability- Pillars of Sustainability- Circle of Sustainability- Need for Sustainability- systems and their sustainability- sustainability in the built environment context- Green Buildings -Difference between Green and Sustainability- Climate Change, Global warming- National and International policies and Regulations on sustainability.

UNIT 2 CONCEPTS OF SUSTAINABILITY **12 Hrs.**

Early man lifestyles- History and development of sustainability- Present day - Scale and context of sustainability- Current Issues and Solutions of sustainability- Vernacular architecture and its relevance.

UNIT 3 PRINCIPLES OF SUSTAINABILITY **14Hrs.**

Political Sustainability, economic sustainability, cultural sustainability, social sustainability, building sustainability- Co-relationship between all - Driving factors of sustainable change- Engineering principles of Sustainability - Systems approach to sustainability.

UNIT 4 APPLICATIONS IN THE BUILT ENVIRONMENT **12 Hrs.**

Concepts of green buildings, climate responsive building - Reduction of energy consumption, direct and indirect methods - Reduction of water consumption, direct and indirect methods- Carbon footprint and eco footprints of buildings- New concepts and trends in green buildings, national and international.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Understand the basics of sustainability and various types of sustainability in the context of built environment.
CO2: Critical analysis of current issues and sustainability solutions.
CO3: Co-relate the various dimensions of sustainability such as political, economic, cultural, social and building sustainability to evolve a holistic approach towards sustainability.
CO4: Comprehend the knowledge on the driving factors of sustainable practices.
CO5: Apply the concepts in creating climate responsive green buildings and in reducing the energy demand of buildings.
CO6: Identify the emerging green building concepts.

TEXT / REFERENCE BOOKS

1. Margaret Robertson, Sustainability Principles and Practice,Routledge, 2014
2. Martin A. A. Abraham , Sustainability Science and Engineering: Defining Principles,Elsevier Science, 2005
3. Tony Clayton, Nicholas J. Radcliffe, Anthony M. H. Clayton, Sustainability: A Systems Approach,Routledge, 1996
4. Stephen M. Stephen, Stephen M. Wheeler, Climate Change and Social Ecology: A New Perspective on the Climate Challenge, Routledge, 2012
5. Gursharan Singh Kainth, Climate Change, Sustainable Development and India, LAP Lambert Academic Publishing, 2011

WEBSITES

1. http://www.sustainabilitylabs.org/page/sustainability-five-core-principles
2. http://www.thwink.org/sustain/glossary/Three Pillars Of Sustainability.htm3.
3. http://www.rcac.org/assets/greenbuild/grn-bldg-guide_4-20-09.pdf
4. http://teamshunya.in/docs/nme-ict/4.font1journey%20of%20sustainibility.pdf

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA5131	CONCEPTS AND PRINCIPLES OF	L	T	P	Credits	Total Marks

	SUSTAINABILITY	3	0	0	3	100

COURSE OBJECTIVES:

- To give a comprehensive introduction on the concepts of sustainability and the governing principles.
- To familiarize the implications of sustainability in various spheres such as social, economic, political and cultural.
- To explore the effective applications of sustainable approaches and principles in architecture.

UNIT 1 INTRODUCTION 9 Hrs.

Definitions of Sustainability- Various types of sustainability- Pillars of Sustainability- Circle of Sustainability- Need for Sustainability- systems and their sustainability- sustainability in the built environment context.

UNIT 2 CONCEPTS OF SUSTAINABILITY 10 Hrs.

Early man lifestyles- History and development of sustainability- Present day - Scale and context of sustainability- Current Issues and Solutions of sustainability- Vernacular architecture and its relevance.National and International policies and Regulations on sustainability. Green Buildings -Difference between Green and Sustainability- Climate Change, Global warming.

UNIT 3 PRINCIPLES OF SUSTAINABILITY 10 Hrs.

Political Sustainability, economic sustainability, cultural sustainability, social sustainability, building sustainability- Co-relationship between all - Driving factors of sustainable change- Engineering principles of Sustainability - Systems approach to sustainability.

UNIT 4 APPLICATIONS IN THE BUILT ENVIRONMENT 10 Hrs.

Concepts of green buildings, climate responsive building - Reduction of energy consumption, direct and indirect methods - Reduction of water consumption, direct and indirect methods- Carbon footprint and eco footprints of buildings- New concepts and trends in green buildings, national and international.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Exercise on Feedback Loop, Carrying Capacity of a system, energy principles of sustainability, Carbon Foot print and eco foot print calculations.

Max. 45 Hours

COURSE OUTCOME:

CO1 Understand the basics of sustainability and various types of sustainability in the context of built environment.

CO2 Critical analysis of current issues and sustainability solutions.

CO3 Co-relate the various dimensions of sustainability such as political, economic, cultural, social and building sustainability to evolve a holistic approach towards sustainability.

CO4 Comprehend the knowledge on the driving factors of sustainable practices.

CO5 Apply the concepts in creating climate responsive green buildings and in reducing the energy demand of buildings.

CO6 Identify the emerging green building concepts.

TEXT / REFERENCE BOOKS

1. Kainth, G. S. *(2011). Climate Change, Sustainable Development and India. New Delhi: LAP Lambert Academic Publishing.*
2. Robertson, M. *(2014). Sustainability Principles and Practice. London: Routledge.*
3. Stephen M. Stephen, S. M. *(2012). Climate Change and Social Ecology: A New Perspective on the Climate Challenge.New York,NY: Routledge.*
4. Tony Clayton, N. J. *(1996). Sustainability: A Systems Approach. Ohio: Routledge.*

WEBSITES

1. http://www.sustainabilitylabs.org/page/sustainability-five-core-principles
2. http://www.thwink.org/sustain/glossary/Three Pillars Of Sustainability.htm3.
3. http://www.rcac.org/assets/greenbuild/grn-bldg-guide_4-20-09.pdf
4. http://teamshunya.in/docs/nme-ict/4.font1journey%20of%20sustainibility.pdf

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**

PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks: 08 x 05 = 40 Marks

PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5132	CLIMATE AND ARCHITECTURE IN TROPICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To provide a holistic understanding of various climatic parameters on built form.
- To familiarize the evolution of climate responsive architecture in the tropics.
- To develop a broad understanding of the relationship between climate and architecture

UNIT 1 CLIMATE AND THERMAL COMFORT IN THE TROPICS 10 Hrs.

Tropical climate, environmental consequences of tropical climate – Building in the tropics - Urban heat island phenomenon: UHI classification, causes, urban geometry, mitigation strategies, UHI in tropics, case studies - Thermal comfort in the tropics – Bio climatic needs of humans- comfort indices for the tropics: ET, SET, PMV – Comfort Temperature, adaptive comfort standard – Thermal comfort in the urban outdoors, outdoor comfort indices: WBGT, PET, OUT-SET.

UNIT 2 TRADITIONAL ARCHITECTURE AND ITS RESPONSE TO CLIMATE 14 Hrs.

Learning from vernacular experience - Regionalist approach to design technology for climate control in the tropics - Relationship between nature and built form - Architecture in the tropics: tropical wet climate, tropical dry climate, tropical monsoon climate zones - Climatic characteristics and physiological needs - Traditional protection: study of vernacular influence and local architecture as response to climatic conditions- Examples from various tropical countries.

UNIT 3 CLIMATE ADAPTATION IN CONTEMPORARY ARCHITECTURE 14 Hrs.

Environmental design & cultural identity – Green design in the tropical climates – socio-environmental dimensions in high rise, high density housing - Building & planning requirements, urban built space ratios, urban street canyons - Contemporary tropical architecture – Contemporary examples from various tropical countries.

UNIT 4 CLIMATE RESPONSIVE DESIGN IN THE TROPICS: PRINCIPLES AND APPLICATIONS 10 Hrs.

Fundamentals of environmentally conscious design in the tropics - Solar radiationprevention – Solar envelope and its development – Promotion of urban wind flowand air movement – Energy efficient urban layout – Tools for enhancing urban environmental quality – Design strategies for the urban tropics, built form, landscape controls, urban parks, vertical landscaping, plant-climate-building model.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Understand the urban heat island phenomenon and its classification
CO2: Comprehend the various thermal comfort indices and their applications in both outdoor and indoor conditions.
CO3: Acquire responsiveness of Vernacular Architecture to climate in different contexts.
CO4: Examine the socio environmental impact of climate adaptation and the role of planning parameters
CO5: Analyze the various approaches adopted to develop environmental conscious designs in the tropics.
CO6: Critical evaluation of design strategies for the urban tropics.

TEXT / REFERENCE BOOKS

1. NyukHien Wong and Yu Chen, Tropical Urban Heat Islands- Climate, Buildings and Greenery, Routledge, 2008
2. M.Rohinton Emmanuel, An Urban Approach to Climate-Sensitive Design – Strategies for the Tropics, Taylor & Francis, London & New York, 2005.
3. Hassan Fathy, Natural Energy and Vernacular Architecture - Principles and Examples with reference to Hot Arid Climates, University of Chicago Press, Chicago and London, 1986.
4. Koenisberger, O. H., Manual of Tropical Housing and Building. Part 1: Climatic Design,OrientBlackswan, 1975
5. Rapaport, A., House form and Culture, Engelwood Cliffs, NJ: Prentice-Hall, 1969
6. Giovoni, B. Ma, Climate and Architecture, 2nd edition. Barkingg, Essex: Applied Science, 1976
7. Fry. M and Drew. J, Tropical Architecture in the Dry and Humid Zones,Londres: Bestford, 1964
8. Joo-Hwa Bay and Boon Lay Ong, Tropical Sustainable Architecture - Social and Environmental Dimensions, Architectural Press, Routledge, 2007.

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA5133	CLIMATE AND ARCHITECTURE IN TROPICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To provide a holistic understanding of various climatic parameters on built form.
- To familiarize the evolution of climate responsive architecture in the tropics.
- To synthesis the relationship between climate and architecture.

UNIT 1 CLIMATE AND THERMAL COMFORT IN THE TROPICS 9 Hrs.

Tropical climate, environmental consequences of tropical climate – Building in the tropics - Urban heat island phenomenon: UHI classification, causes, urban geometry, mitigation strategies, - Thermal comfort in the tropics – factors influencing thermal comfort-comfort indices for the tropics: ET, SET, PMV – Comfort Temperature, adaptive comfort standard – Thermal comfort in the urban outdoors, outdoor comfort indices: WBGT, PET, OUT-SET-basics of bioclimatic chart, Bioclimatic needs of humans.

UNIT 2 TRADITIONAL ARCHITECTURE AND ITS RESPONSE TO CLIMATE 12 Hrs.

Learning from vernacular experience - Regionalist approach to design technology for climate control in the tropics - Relationship between nature and built form - Architecture in the tropics: tropical wet climate, tropical dry climate, tropical monsoon climate zones - Climatic characteristics and physiological needs - Traditional protection: study of vernacular influence and local architecture as response to climatic conditions.

UNIT 3 CLIMATE ADAPTATION IN CONTEMPORARY ARCHITECTURE 9 Hrs.

Environmental design & cultural identity – Green design in the tropical climates – socio-environmental dimensions in high rise, high density housing - Building & planning requirements, urban built space ratios, urban street canyons - Contemporary tropical architecture.

UNIT 4 CLIMATE RESPONSIVE DESIGN IN THE TROPICS: PRINCIPLES AND APPLICATIONS 9 Hrs.

Fundamentals of environmentally conscious design in the tropics - Solar radiation prevention – Solar envelope and its development – Promotion of urban wind flow and air movement – Energy efficient urban layout – Tools for enhancing urban environmental quality – Design strategies for the urban tropics, built form, landscape controls, urban parks, vertical landscaping, plant-climate-building model.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Submit case studies of UHI in tropics through various research articles. Presentation on Vernacular &Contemporary examples from various tropical countries or Site visit to Vernacular built spaces and submission of report.

Max. 45 Hours

COURSE OUTCOME:

CO1 Comprehend the various thermal comfort indices and their applications in both outdoor and indoor conditions.
CO2 Understand the relationship between nature and built form.
CO3 Acquire responsiveness of Vernacular Architecture to climate in different contexts.
CO4 Examine the socio environmental impact of climate adaptation and the role of planning parameters.
CO5 Choose the appropriate approaches adopted to develop environmental conscious designs in the tropics.
CO6 Construct the design strategies from various vernacular and contemporary design examples

TEXT / REFERENCE BOOKS

1. Chen, N. H. (2008). *Tropical Urban Heat Islands- Climate, Buildings and Greenery.* London and New York: Taylor and Fracis.
2. Emmanuel, M. (2005). *An Urban Approach to Climate-Sensitive Design – Strategies for the Tropics.* London & New York: Taylor & Francis.
3. Giovoni, B. (1976). *Man Climate and Architecture.* London: Applied Science Publishers.
4. Koenisberger, O. (1975). *Manual of Tropical Housing and Building, Part 1: Climatic Design.* Chennai: Orient Blackswan.
5. Ong, J.-H. B.-L. (2007). *Tropical Sustainable Architecture - Social and Environmental Dimensions.* New York: Routledge.
6. Rapoport, A. (1969). *House form and Culture.* London: Engelwood Cliffs, NJ: Prentice-Hall.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5133	SUSTAINABILITY IN BUILDING MATERIALS AND TECHNIQUES	L	T	P	Credits	Total Marks
		2	1	0	3	100

COURSE OBJECTIVES:

- To give a comprehensive overview of sustainable building materials and construction techniques.
- To understand the concept of embodied energy of materials in construction industry.
- To synthesize the innovative applications of primary, secondary and tertiary waste as building materials in construction

UNIT 1 INTRODUCTION TO SUSTAINABLE BUILDING MATERIALS **10 Hrs.**

Introduction to sustainable building materials, qualities, use, examples - Natural building materials, locally available and locally manufactured materials, bio materials - Salvaged and recycled materials - Non toxic materials: low VOC paints, coating and adhesives.

UNIT 2 CONCEPT OF EMBODIED ENERGY AND CARBON FOOTPRINT **16 Hrs.**

Idea of embodied energy - Development of the concept, factors to be considered, calculation techniques for embodied energy - Data sets available for calculation of embodied energy - Case studies of embodied energy calculations- Sample embodied energy calculations for a material - Concept of embodied carbon or carbon footprint of material, calculation techniques, methods to off-set high embodied energy - Cradle to cradle material, whole life cycle and life cycle costing analysis techniques.

UNIT 3 SUSTAINABLE CONSTRUCTION TECHNIQUES **12 Hrs.**

Alternative construction techniques such as SMB, CSEB, and steam cured blocks, composite beam and panel, funicular shells, filler slabs, reinforced concrete masonry, vaulted roofs, ferro-cement wallsetc., -Case studies

UNIT 4 INNOVATIVE USE OF MATERIALS **10 Hrs.**

Use of waste materials such as paper, glass bottles, tires, shipping containers - Use of post consumer and industrial waste such as fly-ash, bags, building demolition waste –use of salvaged materials from flooring, columns, beams, timber, glass, etc.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Ability to classify the materials based on the thermal properties, embodied energy and availability.
CO2: Analyze the various methods adopted to calculate the embodied energy ,
CO3: Understand the concept of life cycle costing analysis of building materials.
CO4: Critically appreciate the alternative construction techniques.
CO5: Acquire various innovative methods of using waste materials in constructing both permanent and temporary shelters.
CO6: Comprehension on the ways through which the salvaged materials are used in construction.

TEXT / REFERENCE BOOKS

1. Sustainable Building - Design ManualPt 1 & 2, The Energy and Resources Institute, TERI, 2004
2. GRoss Spiegel, Green Building Materials A Guide to Product Selection and Specification, 3rd Edition by, John Wiley & Sons, 2010
3. K.S. Jagadish,Alternative Building Materials and Technologies, New age International Pvt Ltd Publishers, 2008
4. Traci Rose Rider, Stacy Glass, Jessica McNaughton, Understanding Green Building Materials, W.W.Norton and Company,2011
5. Johan van Lengen,The Barefoot Architect: A Handbook for Green Building, Shelter Publication, 2008

WEBSITES

1. http://www.ijsrp.org/research-paper-1112/ijsrp-p1154.pdf
2. http://www.sustainablebuild.co.uk/ecofriendlyconstructionmethodsmaterials.html
3. http://www.epa.gov/greenhomes/SmarterMaterialChoices.htm
4. http://inhabitat.com/tag/sustainable-building-materials/

SARA5134	SUSTAINABLE BUILDING MATERIALS AND TECHNIQUES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To give a comprehensive overview of sustainable building materials and construction techniques.
- To understand the concept of embodied energy of materials in construction industry.
- To synthesize the innovative applications of primary, secondary and tertiary waste as building materials in construction.

UNIT 1 INTRODUCTION TO SUSTAINABLE BUILDING MATERIALS 9 Hrs.

Introduction to sustainable building materials, qualities, use, examples - Natural building materials, Use of Local materials leading to climate responsive design,Vernacular thought leading to sustainable habitat locally available and locally manufactured materials, bio materials - Salvaged and recycled materials - Non-toxic materials: low VOC paints, coating and adhesives.

UNIT 2 CONCEPT OF EMBODIED ENERGY AND CARBON FOOTPRINT 12 Hrs.

Idea of embodied energy - Development of the concept, factors to be considered, calculation techniques for embodied energy - Data sets available for calculation of embodied energy - Case studies of embodied energy calculations- Sample embodied energy calculations for a material - Concept of embodied carbon or carbon footprint of material, calculation techniques, methods to off-set high embodied energy - Cradle to cradle material, whole life cycle and life cycle costing analysis techniques.

UNIT 3 SUSTAINABLE CONSTRUCTION TECHNIQUES 9 Hrs.

Alternative construction techniques such as SMB, CSEB, and steam cured blocks, composite beam and panel, funicular shells, filler slabs, reinforced concrete masonry, vaulted roofs, ferro-cement walls etc., - Case studies

UNIT 4 INNOVATIVE USE OF MATERIALS 9 Hrs.

Use of waste materials such as paper, glass bottles, tires, shipping containers - Use of post-consumer and industrial waste such as fly-ash, bags, building demolition waste –use of salvaged materials from flooring, columns, beams, timber, glass, etc.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Designing and creating a prototype model using the materials learnt in the above units, calculating the embodied energy for the fabrication, Exercise on carbon print and ecological foot print calculation.

Max. 45 Hours

COURSE OUTCOME:

CO1 Ability to classify the materials based on the thermal properties, embodied energy and availability.
CO2 Analyse the various methods adopted to calculate the embodied energy.
CO3 Understand the concept of life cycle costing analysis of building materials.
CO4 Critically appreciate the alternative construction techniques.
CO5 Acquire knowledge in various innovative methods of using waste materials in constructing both in permanent and temporary shelters.
CO6 Comprehension on the ways through which the salvaged materials are used in construction.

TEXT / REFERENCE BOOKS

1. Jagadish, K. (2008). *Alternative Building Materials and Technologies.* Chennai: New age International Pvt Ltd Publishers.
2. Johan van Lengen, 2. (2008). *A Handbook for Green Building,The Barefoot Architect* : Shelter Publication.
3. Spiegel, G. (2010). *Green Building Materials A Guide to Product Selection and Specification,3rd Edition.* London: John Wiley & Sons,.
4. TERI. (2004). *Sustainable Building - Design Manual Pt 1 & 2.* New Delhi: Teri Press, The Energy And Resources Institute.
5. Traci Rose Rider, S. G. (2011). *Understanding Green Building Materials.* New York : W.W.Norton and Company.
6. Atul Deulgaonkar , (2015). *Laurie Baker,Truth in Architecture.*New Delhi: Jyotsna Prakashan

WEBSITES

1. http://www.ijsrp.org/research-paper-1112/ijsrp-p1154.pdf
2. http://www.sustainablebuild.co.uk/ecofriendlyconstructionmethodsmaterials.html
3. http://www.epa.gov/greenhomes/SmarterMaterialChoices.htm
4. http://inhabitat.com/tag/sustainable-building-materials/

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5610	RESEARCH METHODOLOGIES IN BUILT ENVIRONMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To comprehend the need, role and importance of research in Architecture.
- To understand and synthesize process of research.

UNIT 1 INTRODUCTION **10 Hrs.**

Basic research issues and concepts- Orientation to research process- Types of research: historical, qualitative, co-relational, experimental, simulation and modelling, logical argumentation, case study and mixed methods- illustration using research samples.

UNIT 2 RESEARCH PROCESS **14 Hrs.**

Elements of research process: finding a topic- Writing an introduction- Stating a purpose of study identifying key research questions and hypotheses- Reviewing literature using theory, defining, delimiting and stating the significance of the study, advanced methods and procedures for data collection and analysis- illustration using research samples.

UNIT 3 RESEARCHING AND DATA COLLECTION **14 Hrs.**

Library and archives- Internet: new information and the role of internet, finding and evaluating sources of misuse- Test for reliabilityethics - Methods of data collection- From primary sources: observation and recording, interviews structured and unstructured, questionnaire, open ended and close ended questions and the advantages, sampling- Problems encountered in collecting data from secondary sources.

UNIT 4 REPORT WRITING & CASE STUDIES **10 Hrs.**

Writing &publishing the research work in journals - Research writing in general- Components:referencing- Writing the bibliography- Developing the outline – presentation etc. - Case studies - illustrating how good research can be used from project inception to completion- Review of research publications.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the student will be able to

CO1: Distinguish different types of research in architecture
CO2: Demonstrate an understanding of the process of research and the elements of the research process.
CO3: Ability to review and critically analyze the literature to establish current knowledge of a topic, compare and contrast the various findings, arguments, theories, and methodologies, and problems or gaps in the literature.
CO4: Comprehend the different data collection techniques and their application in a context
CO5: Understanding the basics of research paper writing and publishing.
CO6: Develop and write a preliminary research proposal.

TEXT / REFERENCE BOOKS

1. Wayne C Booth, Joseph M Williams, Gregory G Colomb, The Craft of Research,2nd Edition, Chicago guides to writing, editing and publishing, 1995
2. Iain Borden, KaaterinaRuedi, The Dissertation: An Architecture Student's Handbook, Architectural Press, 2000
3. Ranjith Kumar, Research Methodology- A step by step guide for beginners, Sage Publications, 2005
4. John W Creswell, Research design: Qualitative, Quantitative and Mixed method approaches, Sage Publications, 2002
5. Linda N. Groat, David Wang, Architectural Research methods, Wiley, 2nd edition, 2013

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA5104	RESEARCH METHODOLOGIES IN BUILT ENVIRONMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To comprehend the need, role and importance of research in Architecture.
- To understand and synthesize process of research.
- To give an insight to report writing and publishing research work in journals.

UNIT 1 INTRODUCTION 6 Hrs.

Introduction to research - Orientation to research process- Types of research: Quantitative, Qualitative, Mixed methods -Strategies for Architectural research: historical, qualitative, co-relational, experimental, simulation and modelling, logical argumentation, case study and combined methods- illustration using research samples.

UNIT 2 RESEARCH PROCESSES 12 Hrs.

Research process- Formulating a research problem- conceptualizing research Design-Stating a purpose of study identifying key research questions and hypotheses- Reviewing literature using theory, defining, delimiting and stating the significance of the study, - illustration using research samples.

UNIT 3 DATA COLLECTION AND ANALYSIS 12 Hrs.

Methods of data collection- Primary and secondary: observation and recording, interviews structured and unstructured, questionnaire, open ended and close ended questions and the advantages, sampling- Problems encountered in collecting data from secondary sources– Basics of processing and analysis of data: classification and tabulation of data, Overview of types of quantitative analysis: Multiple regression, Multiple discriminant analysis, Multivariate analysis of variance, Inferential analysis – Methods of qualitative analysis.

UNIT 4 REPORT WRITING & CASE STUDIES 9 Hrs.

Writing &publishing the research work in journals- Research Metrics: Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score, Metrics: h-index, g index, i10 index, altmetrics - Research writing in general- Components: referencing- Writing the bibliography- Developing the outline – presentation etc.-. Databases: Indexing databases, Citation databases: Web of Science, Scopus, etc. Research ethics: intellectual honestyand research integrity, Scientific misconduct: falsification, fabrication, and plagiarism

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Write review on selected papers or books individually and submit report on the same. Submit abstract of a paper on interested topic with references in APA style.

Max.45 Hours

COURSE OUTCOME:

CO1 Distinguish different types of research in architecture

CO2 Demonstrate an understanding of the process of research and the elements of the research process.

CO3 Ability to review and critically analyze the literature to establish current knowledge of a topic, compare and contrast the various findings, arguments, theories, and methodologies, and problems or gaps in the literature.

CO4 Comprehend the different data collection techniques and their application in a context.

CO5 Understanding the basics of research paper writing and publishing.

CO6 Develop and write a preliminary research proposal.

TEXT / REFERENCE BOOKS

1. Groat, L. N., & Wang, D. (2013). *Architectural research methods*. John Wiley & Sons.
2. Creswell, J. W., & Creswell, J. D. (2017) *Research design: Qualitative, quantitative, and mixed methods approaches.* Sage publications.
3. Kumar, R. (2019). *Research methodology: A step-by-step guide for beginners*, Sage Publications Limited.
4. Booth, W. C., Booth, W. C., Colomb, G. G., Colomb, G. G., Williams, J. M., & Williams, J. M. (2016). *The craft of research*. University of Chicago press.
5. Borden, I. (2006). *The dissertation*. Routledge.4.
6. The Ethics of Online Research (Advances in Research Ethics and Integrity Book 2) Kindle Edition by Kandy Woodfield (Editor), 2017.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**

PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks

PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR6510	SUSTAINABLE DESIGN STUDIO I	L	T	P	Credits	Total Marks
		0	0	14	7	200

COURSE OBJECTIVE:

- To identify contemporary relevance of sustainable principles from vernacular buildings and to compare/ contrast the same with recent buildings.

STUDIO BRIEF

CASE STUDY 1

To identify and document a building or a group of buildings from a pre-industrial, vernacular, traditional settlement in India and

- to comprehensively study the building in terms of it layout, use of materials, spatial and environmental concepts, user comfort, ambience, distinct features etc.,
- understand its climate responsive design strategies, sustainable practices and their contemporary relevance.

CASE STUDY 2

To identify a modern building or a group of buildings built within the last decade and

- document and analyze their layouts, use of materials, spatial and environment concepts, ambience, user comfort etc.,

COMPARISON OF CASE STUDIES 1 AND 2

- To compare and contrast case studies 1 and 2 to understand the shift in societal values and their subsequent effect on sustainability

DELIVERABLES

Students shall submit case study documentation sheets with requisite sketches, photographs, models, cognitive analysis diagrams, empirical documentation, detailed narratives and position papers and present as a seminar.

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Understand and document the sustainable principles and practices, and passive design strategies in a built environment.
CO2: Demonstrate a heightened awareness of sustainability as a multidimensional concept and awareness of the environmental factors influencing the built environment and vice versa.
CO3: Critically analyze, evaluate and make informed judgment on the working of sustainable design strategies in vernacular and contemporary buildings
CO4: Develop design strategies that optimize and conserve resources and provide comfortable environment for the occupants in a building
CO5: Ability to use software tools to analyze sustainability in the built environment.
CO6: Acquired knowledge on finding solution for development of sustainable practices in current scenario.

TEXT / REFERENCE BOOKS

1. Gursharan Singh Kainth, Climate Change, Sustainable Development and India, LAP Lambert, 2011
2. Janis Birkeland, Positive Development: From Vicious Circles to Virtuous Cycles through Built Environment Design, Routledge, 2008
3. Sustainable Building - Design Manual: sustainable building design practices- TERI 2004
4. Ross Spiegel, Green Building Materials: A Guide to Product Selection and Specification, 3rd Edition, John Wiley & Sons, 2010
5. K.S. Jagadish, Alternative building materials and technologies, New Age International, 2013
6. The Barefoot Architect: A Handbook for Green Building, Shelter Publication, 2007

SARA9131	SUSTAINABLE DESIGN STUDIO I	L	T	P	Credits	Total Marks
		0	0	12	6	300
Continuous Assessment		University Viva			Min Pass Marks	
200		100			150	

COURSE OBJECTIVE:

- To identify contemporary relevance of sustainable principles in vernacular buildings and to compare/ contrast the same with recent buildings.
- To understand the difference in the sustainable principles adapted in vernacular buildings against contemporary buildings and the significance of passive techniques
- To understand and apply the climate responsive passive strategies on a small-scale building design

STUDIO BRIEF 01

CASE STUDY 1

To identify and document a building or a group of buildings from a pre-industrial, vernacular, traditional settlement in India and

- To comprehensively study the building in terms of it layout, use of materials, spatial and environmental concepts, user comfort, ambience, distinct features etc.,
- Understand its climate responsive design strategies, sustainable practices and their contemporary relevance.

CASE STUDY 2

To identify a modern building or a group of buildings built within the last decade and

- document and analyze their layouts, use of materials, spatial and environment concepts, ambience, user comfort etc.,

COMPARISON OF CASE STUDIES 1 AND 2

- To compare and contrast case studies 1 and 2 to understand the shift in societal values and their subsequent effect on sustainability

PROPOSAL

Propose changes or modifications (Façade modifications / passive strategy application) to the 'lesser performing case' and prove its enhanced climate responsiveness.

DELIVERABLES

Students shall submit case study documentation sheets with requisite sketches, photographs, models, cognitive analysis diagrams, empirical documentation, detailed narrativesand proposal for modification and enhancement of one of the cases based on the analysis.

STUDIO BRIEF 02

1. The students shall design a residential building which shall function as per ECBC guidelines
2. Students shall select any one climatic zone from ECBC's climatic zone classification.
3. They shall select any city from a zone and research local bye laws and regulations.
4. They shall analyse site fit and program brief
5. They shall evaluate cultural, environmental factors and inspirations for environmental design from local vernaculararchitectureand nature.
6. The building should highlight at least one local material and one material which has low embodied energy as compared to conventional technology.

DELIVERABLES

1. Study report on climatic and microclimatic parameters that will guide environmental site development.
2. Study report and story board incorporating site fit, zoning and program brief, contextual adaptations from vernacular/ nature responses, conceptual design.
3. Residential typology precedent analysis and Preliminary energy analysis
4. Architectural documentation including 2D drawings and 3D models
5. Detailing and modelling of green building features emphasizing passive design features.
6. Detailed calculations as per ECBC standards.

COURSE OUTCOME:

CO1 Understand and document the sustainable principles and practices, and passive design strategies in a built environment.

CO2 Demonstrate a heightened awareness of sustainability as a multidimensional concept and awareness of the environmental factors influencing the built environment and vice versa.

CO3 Critically analyze, evaluate and make informed judgment on the working of sustainable design strategies in vernacular and contemporary buildings

CO4 Develop design strategies that optimize and conserve resources and provide comfortable environment for the occupants in a buildingin a particular climate

CO5 Ability to use software tools to analyze sustainability in the built environment.

CO6 Applying Passive strategies and finding solution for development of sustainable practices in a small-scale building.

TEXT / REFERENCE BOOKS

1. Deulgaonkar, A. (2015). *Laurie Baker, Truth in Architecture.* New Delhi: Jyotsna Prakashan.
2. Kainth, G. S. (2011). *Climate Change, Sustainable Development and India.* New Delhi: LAP Lambert.
3.Lengen, J. V. (2007). *The Barefoot Architect: A Handbook for Green Building.* California, USA: Shelter Publication.

SAR 5134	CLIMATOLOGY AND BUILDING PHYSICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To understand the dynamic interaction between building physics and climatic elements
- To explore the impact of climate on occupant comfort and environment.
- To interpret the effect of climate on building envelope and building components

UNIT 1 CLIMATE AND ENERGY EFFICIENCY **10 Hrs.**

Impact of urban density on energy demand and potential for solar energy utilization - Residential densities and application of passive solar systems - Impact of material finishes on urban climate and energy demand - Evaluating the efficiency of shading devices- Users response and energy consumption profile in bioclimatic Architecture - Integrated environment and energy planning.

UNIT 2 THERMAL BEHAVIOUR OF BUILDING **12 Hrs.**

Thermal behaviour of multi layers: body, surface conductance, air-to-air resistance, cavity resistance, heat exchange in buildings, solar control – Radiation calculations – Solar heat gain - Periodic heat flow calculations, steady-state heat flow, insulation, thermal bridges, window wall ratio/ skylight roof ratio- Dynamic response of buildings – Insulation: resistive insulation, reflective insulation, capacitive insulation. Daylight and sunlight – Day-lighting luminance, overshadowing, plotting sky cover – Determination of day lighting factors, control of sunlight, and beam sun-lighting - Experimental characterization for day-lighting - Innovative components.

UNIT 3 BUILDING ENVELOPE **12 Hrs.**

Streets and buildings- room zoning- layer of shades, overhead shades – Solar organizations: heat producing zones, stratification zones, buffer zones, daylight zones – Shape and enclosure: direct gain, sun-spaces, thermal storage walls, roof ponds, thermal collector walls, wind catchers – Courtyards: size, shape, orientation, breezy and shady courtyards - Estimation of skin heat flow, window solar gain, ventilation / infiltration gain or loss.

UNIT 4 BUILDING COMPONENTS **14 Hrs.**

Walls, roofs, floors and windows: size - shape, orientation, materials, colour – skin thickness, mass surface absorption, daylight reflecting surfaces, double skin materials, solar reflectors, skylight wells, breathing walls -solar apertures, daylight apertures, area of window openings based on ventilation load – Light shelves, daylight enhancing shades, internal and external shading - Elements of urban climatology.

max. 48 hours

COURSE OUTCOMES:

CO1: Understanding the impact of urban density on energy demand
CO2: Ability to comprehend energy consumption profile in Bioclimatic architecture
CO3: Explore the thermal behavior of multi layers of a building
CO4: Calculating the day light luminance and plotting of sky cover
CO5: Comprehensive understanding of direct gain system, sun spaces, thermal storage walls, etc.
CO6: Evaluating the role of building components in thermal comfort and elements of urban climatology

TEXT / REFERENCE BOOKS

1. Steven V. Szokolay, Introduction to Architectural Science: The basis of sustainable design, Architectural Press, 2004.
2. G.Z.Brown and Mark Dekay, Sun, Wind &Light : Architectural Design Strategies, John Wiley & Sons inc.,2001.
3. Aravind Krishna, Nick Baker, SimosYannas and S V Szokolay, Climate Responsive Architecture: a Design handbook for energy efficient buildings, McGraw-Hill Education (Asia) Co. and China Architecture & Building Press, 2005.
4. Koenisberger, O. H., Manual of Tropical Housing and Building. Part 1: Climatic Design,OrientBlackswan, 1975.
5. Fry, M. and Drew, J., Tropical Architecture in the Dry and Humid Zones,Londres: Bestford, 1964
6. Joo-Hwa Bay and Boon Lay Ong, Tropical Sustainable Architecture - Social and Environmental Dimensions, Architectural Press, Routledge, 2007.
7. Cairns Regional Council, Sustainable Tropical Building Design- Guidelines for commercial buildings, 2011.

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA5231		L	T	P	Credits	Total Marks

	CLIMATOLOGY AND BUILDING PHYSICS	3	0	0	3	100

COURSE OBJECTIVES:

- To understand the dynamic interaction between building physics and climatic elements.
- To explore the impact of climate on occupant comfort and environment.
- To interpret the effect of climate on building envelope and building components.

UNIT 1 CLIMATE AND ENERGY EFFICIENCY 9 Hrs.

Impact of urban density on energy demand and potential for solar energy utilization - Residential densities and application of passive solar systems - Impact of material finishes on urban climate and energy demand - Evaluating the efficiency of shading devices- Users response and energy consumption profile in bioclimatic Architecture - Integrated environment and energy planning.

UNIT 2 THERMAL BEHAVIOUR OF BUILDING 12 Hrs.

Thermal behavior of multi layers: body, surface conductance, air-to-air resistance, cavity resistance, heat exchange in buildings, solar control – Radiation calculations – Solar heat gain - Periodic heat flow calculations, steady-state heat flow, insulation, thermal bridges, thermal insulation. Heat loss through common building elements due to transmission, R-values and U-values-window wall ratio/ skylight roof ratio- Dynamic response of buildings – Insulation: resistive insulation, reflective insulation, capacitive insulation. Daylight and sunlight – Day-lighting and its applications using software – Determination of day lighting factors, control of sunlight, and beam sun-lighting - Experimental characterization for day-lighting - Innovative components.

UNIT 3 BUILDING ENVELOPE & ZONING 9 Hrs.

Streets and buildings- room zoning- layer of shades, overhead shades – Solar organizations: heat producing zones, stratification zones, buffer zones, daylight zones – Shape and enclosure: direct gain, sun-spaces, thermal storage walls, roof ponds, thermal collector walls, wind catchers – Courtyards: size, shape, orientation, breezy and shady courtyards - Estimation of skin heat flow, window solar gain, ventilation / infiltration gain or loss.

UNIT 4 BUILDING COMPONENTS 9 Hrs.

Walls, roofs, floors and windows: size - shape, orientation, materials, colour – skin thickness, mass surface absorption, daylight reflecting surfaces, double skin materials, solar reflectors, skylight wells, breathing walls -solar apertures, daylight apertures, area of window openings based on ventilation load – Light shelves, daylight enhancing shades, internal and external shading.

UNIT 5 COMPREHENSIVELEARNING 6 Hrs.

Estimating heat gain or heat loss in buildings, take up any one building and do the exercise. Alternatively select a climate type and critically analyze the building envelope in that climate.

Max.45 Hours

COURSE OUTCOME:

CO1 Understand the integrated environment and energy plan.
CO2 Summarize the thermal behaviour of multi layers of a building.
CO3 Acquireknowledge on calculation of day light luminance and plotting of sky cover.
CO4 Categorize and understanding of direct gain system, sun spaces, thermal storage walls, etc.
CO5 Evaluating the role of building components in thermal comfort and elements of urban climatology.
CO6 Construct the conceptual frame work from various research papers related to energy efficiency.

TEXT / REFERENCE BOOKS

1. Aravind Krishnan, N. B. (2005). *Climate Responsive Architecture: a Design handbook for energy efficient buildings* . Taipei: McGraw-Hill Education (Asia) Co. and China Architecture & Building Press,.
2. Cairns Regional Council. (2011). *Sustainable Tropical Building Design- Guidelines for commercial buildings.* cairns: Routledge.
3. Fry, M. a. (1964). *Tropical Architecture in the Dry and Humid Zones.* Bestford: Londres.
4. G.Z.Brown and Mark Dekay, 2. (2001). *Sun, Wind &Light : Architectural Design Strategies.* New York: John Wiley & Sons inc.
5. H, K. O. (1975). *Manual of Tropical Housing and Building. Part 1: Climatic Design.* Hyderabad: Orient Blackswan.
6. Ong, J.-H. B. (2007). *Tropical Sustainable Architecture - Social and Environmental Dimensions.* Routledge: Architectural Press.
7. Steven V. Szokolay. (2004). *Introduction to Architectural Science: The basis of sustainable design.* Abingdon-on-Thames: Architectural Press.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5135	TECHNOLOGY FOR ENERGY EFFICIENT BUILDINGS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To understand the various aspects of natural and mechanized ventilation.
- To give a comprehensive introduction and the principles of natural and artificial lighting.
- To explore the fundamentals of integrating services in buildings.

UNIT 1 HVAC TECHNOLOGIES **10 Hrs.**

Factors affecting HVAC Design - Types of Cooling systems air cooled, water cooled, chilled beams, chilled slabs, pre-cooling, free-cooling, VFD drives, etc. - Individual controls and VAV boxes - Natural refrigerants, combined heat power systems- Types of heating systems, radiant heating, solar heating -Conservatory design.

UNIT 2 DAYLIGHTING& ARTIFICIAL LIGHTING **12 Hrs.**

Principles of day lighting design - Day lighting requirements, daylight protractor, day lighting sensors - Glare reduction systems and devices - Day lighting pipes - Shading design - Artificial lighting - Principles of lighting systems, lighting design systems - Occupancy sensors - Glare reduction techniques.

UNIT 3 VENTILATION TECHNIQUES **14 Hrs.**

Requirements of ventilation as per ASHRAE/ECBC - Natural ventilation: stack effect, courtyard effect, air changes, ventilation requirement calculations, cross ventilation - Artificial ventilation techniques: forced ventilation, fresh air systems, pre-cooling of fresh air - Heat recovery through economizers and desiccant wheels - Humidity control systems, demand controlled ventilation

UNIT 4 BUILDING SERVICES INTEGRATION **12 Hrs.**

Integration of various building systems- Building automation systems and intelligent building systems - Integration of HVAC systems with water supply and treatment systems - Occupant responsive buildings - Building information modelling - Green building case studies - Cost analysis of green buildings and ordinary buildings- Capital investment vs. maintenance/operating costs.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Understand the various types of cooling and heating systems.
CO2: Explore the principles of day lighting systems.
CO3: Ability to comprehend the ventilation requirements as per ASHRAE/ECBC.
CO4: Critical understanding of the differences between cooling and heating system.
CO5: Outline the various methods to integrate automation of building systems in buildings.
CO6: Comparative analysis of strategies to integrate services adopted in green buildings through case studies.

TEXT / REFERENCE BOOKS

1. Martin Evans, Housing, Climate and comfort, Architectural Press, London 1980
2. Handbook of functional requirements of Buildings, Bureau of Indian standards SP41, 1987
3. David Egan, Concepts in Thermal comfort, Prentice Hall, 1975
4. Energy Conservation Building Code of India, User manual, 2007
5. ASHRAE 90.1 User Manual, 2007
6. Brian Atkin,Intelligent Buildings: Applications of IT and Building Automation to High Technology Construction Projects, Kogan Page limited, London, 1988
7. Peter Tregenza and Michael Wilson, Daylighting: Architecture and Lighting Design, Routledge, 2011
8. Francis Allard, Natural Ventilation in Buildings: A Design Handbook (BEST (Buildings Energy and Solar Technology)), Routledge, 1998
9. H.B. Awbi, Ventilation of Buildings, Routledge, 2013

WEBSITES

1. http://www.wbdg.org/resources/daylighting.php
2. http://www.wbdg.org/resources/efficientlighting.php
3. http://www.wbdg.org/resources/hvac_humidclimates.php

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100		**Exam Duration: 3 Hrs.**
PART A	**: 2 questions from each unit, each carrying 4 marks.**	**: 08 x 05 = 40 Marks**
PART B	**: 2 questions from each unit with an internal choice, each carrying 15 marks**	**: 04 x 15 = 60 Marks**

SARA5232	TECHNOLOGY FOR ENERGY EFFICIENT BUILDINGS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To understand the influence of HVAC technology on energy efficient buildings.
- To give a comprehensive introduction and the principles of natural and artificial lighting.
- To explore the fundamentals of integrating services in buildings.

UNIT 1 HVAC TECHNOLOGIES 9 Hrs.

Factors affecting HVAC Design - Types of Cooling systems air cooled, water cooled, chilled beams, chilled slabs, pre-cooling, free-cooling, VFD drives, etc.- ducting design, Individual controls and VAV boxes - Natural refrigerants,-types of air conditioning- combined heat power systems- Types of heating systems, radiant heating, solar heating -Conservatory design.

UNIT 2 DAYLIGHTING & ARTIFICIAL LIGHTING 12 Hrs.

Principles of day lighting design - Day lighting requirements, daylight protractor, day lighting sensors - Glare reduction systems and devices – Daylight harnessing systems -Daylight system with shading design - Artificial lighting - Principles of lighting systems, lighting design systems - Occupancy sensors - Glare reduction techniques.

UNIT 3 VENTILATION TECHNIQUES 9 Hrs.

Requirements of ventilation as per ASHRAE/ECBC - Natural ventilation: stack effect, courtyard effect, air changes, ventilation requirement calculations, cross ventilation - Artificial ventilation techniques: forced ventilation, fresh air systems, pre-cooling of fresh air - Heat recovery through economizers and desiccant wheels - Humidity control systems, demand controlled ventilation.

UNIT 4 BUILDING SERVICES INTEGRATION 9 Hrs.

Integration of various building systems - Building automation systems and intelligent building systems - Integration of HVAC systems with water supply and treatment systems - Occupant responsive buildings - Building information modelling- Case studies explaining various building systems.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Exercise to work out cooling load, dehumidifying and heat load estimate. Comparative cost analysis (Capital investment vs maintenance/operating costs) against green buildings and ordinary buildings.

Max.45 Hours

COURSE OUTCOME:

CO1 Comprehend the various types of air conditioning
CO2 Understanding the principles of day lighting systems.
CO3 Acquire knowledge on adopting the various daylight harnessing systems.
CO4 Ability to categorize the ventilation requirements as per ASHRAE/ECBC.
CO5 Evaluate the various methods to integrate automation of building systems in buildings.
CO6 Develop the strategies to integrate services adopted in buildings through case studies.

TEXT / REFERENCE BOOKS

1. Allard, F. (1998). *Natural Ventilation in Buildings: A Design Handbook (BEST (Buildings Energy and Solar Technology))*. London: Routledge.
2. ASHRAE. (2007). *ASHRAE 90.1 user manual.* Atlanta: ASHRAE.
3. Brian Atkin. (1988). *Intelligent Buildings: Applications of IT and Building Automation to High Technology Construction Projects.* London: Kogan page limited.
4. David Egan, l. (1975). *Concepts in Thermal comfort.* Prentice: Prentice Hall.
5. Evans, M. (1980). *Housing, Climate and comfort.* London: Architectural Press.
6. Power, M. o. (2007). *Energy Conservation Building Code of India, User manual.* New Delhi: Ministry of Power.
7. standard, B. o. (1987). *Handbook of functional requirements of Buildings.* New Delhi: Bureau of Indian standard.
8. Wilson, P. T. (2011). *Daylighting: Architecture and Lighting Design,.* London: Routledge.

WEBSITES

1. http://www.wbdg.org/resources/daylighting.php
2. http://www.wbdg.org/resources/efficientlighting.php
3. http://www.wbdg.org/resources/hvac_humidclimates.php

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5136	PERFORMANCE ANALYSIS OF BUILDINGS	L	T	P	Credits	Total Marks
		2	1	0	3	100

COURSE OBJECTIVES:

- To introduce the need for performance analysis of buildings and the emergent outcomes.
- To comprehend the fundamentals of shading devices and the tools for shading analysis.
- To analyze energy use through open source software.

UNIT 1 PERFORMANCE OF BUILDINGS **8 Hrs.**

Need for performance analysis of buildings- Investigation and assessment, energy audit procedures - Design investigations- Energy conservation measure calculations - Modelling systems: cognitive, empirical and analytical assessment of buildings.

UNIT 2 WHOLE BUILDING ENERGY SIMULATION **16 Hrs.**

Modelling the Building form - Parametric and empirical building simulation - Factors affecting accuracy of energy model- Thermal performance criteria of buildings- Envelope considerations, climatic analysis, weather data- Heating and cooling systems modelling, ventilation systems modelling - Energy use analysis through open source software such as EQUEST

UNIT 3 DAYLIGHTING AND SHADING SIMULATIONS **14 Hrs.**

Day lighting simulation models- Day lighting simulation criteria- Factors affecting accuracy of day lighting model - Day lighting simulation exercises using daylight modelling tools - Shading simulations- Principles of shading design- Tools for shading analysis- Tools for shading design - Shading design exercises using open source shading software - BIM Integration.

UNIT 4 ANALYSIS OF BUILDING PERFORMANCE **10 Hrs.**

Metering systems - Analysis of collected data from existing buildings - Economic aspects of energy simulation results: LCA, payback analysis, break even analysis, benefit cost analysis, present worth analysis, etc. - Selection of appropriate ECM from modelling results-Recalibration of the model from actual performance data.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Ability to investigate the performance of buildings through calculations
CO2: Acquired knowledge on whole building energy simulation.
CO3: Comprehensive understanding to the parametric and empirical building simulation for analysis.
CO4: Skill to develop building models for shading analysis, thermal performance of built forms.
CO5: An overview of the various factors which influence accuracy of energy modeling of buildings.
CO6: An understanding to the analysis of various parameters to assess the building performance.

TEXT / REFERENCE BOOKS

1. Teaming for Efficiency: technologies, design, performance analysis and building industry trends, American Council for an Energy-Efficient Economy, 2002
2. James P. Waltz,Computerized Building Energy Simulation Handbook, Fairmont PR, 1997
3. Joseph Clarke, Energy Simulation in Building Design, Routledge, 2007
4. GiulianoDall'O', Green Energy Audit of Buildings: A guide for a sustainable energy audit of buildings, Springer, 2013
5. ASHRAE Press, The ASHRAE Green Guide, Butterworth- Heinemann, 2006
6. Energy Conservation Building Code of India- User manual, 2007

WEBSITES

1. http://doe2.com/download/equest/eQ-v3-63_Introductory-Tutorial.pdf
2. http://ocw.mit.edu/courses/architecture/4-430-daylighting-spring-2012/
3. http://www.photosolar.dk/userfiles/file/Dokumenter/Guideline%20to%20daylight%20calculation_2013.pdf

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA5233	PERFORMANCE ANALYSIS OF BUILDINGS	L	T	P	Credits	Total Marks
		2	0	1	3	100

COURSE OBJECTIVES:

- To introduce the need for performance analysis of buildings and the emergent outcomes.
- To comprehend the fundamentals of shading devices and the tools for shading analysis.
- To analyze energy use through open source software.

UNIT 1 PERFORMANCE OF BUILDINGS 9 Hrs.

Need for performance analysis of buildings - Soft Computation - Investigation and assessment, energy audit procedures - Design investigations- Energy conservation measure calculations - Modelling systems: cognitive, empirical and analytical assessment of buildings – Parametric and empirical building simulations.

UNIT 2 WHOLE BUILDING ENERGY SIMULATION 12 Hrs.

Modelling the Building form - Parametric and empirical building simulation - Factors affecting accuracy of energy model- Thermal performance criteria of buildings- Envelope considerations, climatic analysis, weather data- Heating and cooling systems modelling, ventilation systems modelling. Computing energy required for heating/ cooling needs through open source software's.

UNIT 3 DAYLIGHTING AND SHADING SIMULATIONS 12 Hrs.

Shading simulations- Principles of shading design- Tools for shading analysis- Tools for shading design - Shading design exercises using open source shading software - Day lighting simulation models- Day lighting simulation criteria- Factors affecting accuracy of day lighting model - Day lighting simulation exercises using daylight modelling tools - BIM Integration.

UNIT 4 ANALYSIS OF BUILDING PERFORMANCE 6 Hrs.

Metering systems - Analysis of collected data from existing buildings - Economic aspects of energy simulation results: LCA, payback analysis, break even analysis, benefit cost analysis, present worth analysis, etc. - Selection of appropriate ECM from modelling results-Recalibration of the model from actual performance data.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Based on understanding of above Units the students are expected to perform Whole building computation of a small project emphasizing on the material selection.

Max.45 Hours

COURSE OUTCOME:

CO1 Ability to investigate the performance of buildings through calculations
CO2 Acquired knowledge on whole building energy simulation.
CO3 Comprehensive understanding of the parametric and empirical building simulation.
CO4 Skills to develop building models for shading analysis and understand thermal performance of built forms.
CO5 Evaluate the various factors which influence energy modeling of buildings.
CO6 Understanding the various parameters to assess the building performance.

TEXT / REFERENCE BOOKS

1. ASHRAE. (2006). *The ASHRAE Green GuidE.* Butterworth- Heinemann: ASHRAE Press.
2. Clarke, J. (2007). *Energy Simulation in Building Design.* Routledge: Architectural Press.
3. GiulianoDall'O'. (2013). *Green Energy Audit of Buildings: A guide for a sustainable energy audit of buildings.* New York: Springer.
4. Power, M. o. (2007). *Energy Conservation Building Code of India, User manual.* New Delhi: Ministry of Power.
5. Waltz, J. P. (1997). *Computerized Building Energy Simulation Handbook.* Fairmont: Fairmont PR.
6. Wilson, P. T. (2011). *Daylighting: Architecture and Lighting Design,.* London: Routledge.

WEBSITES

1.http://doe2.com/download/equest/eQ-v3-63_Introductory-Tutorial.pdf
2.http://ocw.mit.edu/courses/architecture/4-430-daylighting-spring-2012/
3.http://www.photosolar.dk/userfiles/file/Dokumenter/Guideline%20to%20daylight%20calculation_2013.pdf

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5137	SUSTAINABLE WATER MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To understand the traditional knowledge of managing water in various contexts.
- To familiarize the fundamentals of technology for effective water management.
- To comprehend the strategies to reduce water consumption in buildings.

UNIT 1 WATER MANAGEMENT – HISTORICAL PERSPECTIVE **8Hrs.**

Traditional community wisdom regarding water management from different climatic zones of the world - Traditional Architecture of wells in Rajasthan, Gujarat, Tamilnadu– Stepped Wells, Baoris, Tankas, etc.

UNIT 2 WATER MANAGEMENT – MACRO LEVEL **12 Hrs.**

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 - Planning of settlements and large campuses based on principles of sustainable watershed development with water as a priority resource.

UNIT 3 WATER MANAGEMENT – MICRO LEVEL **14Hrs.**

Design for water conservation – Building and products - Designing building services, plumbing and sanitary design for effective water reuse, recycling, and recharge - Strategies for water pricing and its regulation - Rain water harvesting techniques – Basic Concepts, piping techniques and pit design for groundwater recharge wells.

UNIT 4 STRATEGIES TO REDUCE WATER CONSUMPTION IN BUILDINGS **14Hrs.**

Low flow plumbing fixtures for water efficient appliances - Rain water harvesting - Reuse of grey water for non potable uses - Wetlands for natural waste water treatment, use of wetlands for natural storm water and vegetated roof tops, (natural) renewable power source such as photo voltaic, solar hot water fuel cells etc.

Max. 48 hours

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Acquire knowledge on the ways to manage water from different climatic zones in Indian context.
CO2: Explore the importance of water management from the social, environmental and economical perspectives.
CO3: Comprehensive knowledge of incorporating sustainable principles of watershed development in large campuses.
CO4: Ability to incorporate the various methods to reduce, recycle and recharge water at the building level.
CO5: Understandings the rationale behind water pricing and regulations
CO6: Outline the fundamentals of renewable power sources.

TEXT / REFERENCE BOOKS

1. John Briscoe,R.P.S. Malik(Ed.), Handbook of Water Resources in India: Development, Management, and Strategies, Oxford University Press, 2007
2. Ramaswamy R. Iyer, Water and the laws in India, Sage Publications India Pvt. Ltd, 2009
3. Hydrology and Water Resources of India, Water Science and Technology Library, Vol. 57, Jain, Sharad K., Agarwal, Pushpendra K., Singh, Vijay P. Springer,2007
4. Guy Honore(Ed.), Principles and Practices of Integrated Watershed Management in India, Indo-German Bilateral Project, 2002
5. K. Nageswara (Ed.), Water Resources Management: Realities and Challenges, Eastern Book Corpn.,2006
6. Dr B C Punmia, Ashok Kr Jain, Arun Kr Jain; Water Supply Engineering,Laxmi,Cunliffe, D. (ed) (2011), Water safety in buildings, World Health Organization, Geneva, Switzerland, 2011
7. P.K. Singh, Rainwater Harvesting: Low cost indigenous and innovative technologies, Macmillan Publishers India, 2008
8. R.N. Athavale,Water Harvesting And Sustainable Supply In India, Rawat Publications, 2003

WEBSITES

1. http://www.unepfi.org/fileadmin/publications/water/chief_liquidity1_India.pdf
2. http://wrmin.nic.in
3. http://www.unicef.org/india/Final_Report.pdf

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA5234	SUSTAINABLE WATER MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To understand the traditional knowledge of managing water in various contexts.
- To familiarize the fundamentals of technology for effective water management.
- To comprehend the strategies to reduce water consumption in buildings.

UNIT 1 WATER MANAGEMENT – HISTORICAL PERSPECTIVE 9 Hrs.

Traditional community wisdom regarding water management from different climatic zones of the world - Traditional Architecture of wells in Rajasthan, Gujarat, Tamil Nadu– Stepped Wells, Baoris, Tankas, etc.

UNIT 2 WATER MANAGEMENT – MACRO LEVEL 12 Hrs.

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 - Planning of settlements and large campuses based on principles of sustainable watershed development with water as a priority resource.

UNIT 3 WATER MANAGEMENT – MICRO LEVEL 9 Hrs.

Design for water conservation – Building and products - Designing building services, plumbing and sanitary design for effective water reuse, recycling, and recharge - Strategies for water pricing and its regulation - Rain water harvesting techniques – Basic Concepts, piping techniques and pit design for groundwater recharge wells.

UNIT 4 STRATEGIES TO REDUCE WATER CONSUMPTION IN BUILDINGS 9 Hrs.

Low flow plumbing fixtures for water efficient appliances - Rain water harvesting - Reuse of grey water for non-potable uses - Wetlands for natural waste water treatment, use of wetlands for natural storm water and vegetated roof tops, (natural) renewable power source such as photo voltaic, solar hot water fuel cells etc.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Submission of reports by interviewing those involved in rainwater harvesting and water management system. Critically analyse water management strategy adopted in any particular case study.

Max.45 Hours

COURSE OUTCOME:

CO1 Understand the basic concepts on the ways to manage water in different climatic zones specific to Indian context.
CO2 Summarize the importance of water management from the social, environmental and economic perspectives.
CO3 Construct knowledge of incorporating sustainable principles of watershed development in large campuses.
CO4 Ability to analyze the various methods to reduce, recycle and recharge water at the building level.
CO5 Criticize the fundamentals of renewable power sources.
CO6 Develop a strategy that can be achieved from practical knowledge in the water management system.

TEXT / REFERENCE BOOKS

1. (Ed.), K. N. (2006). *Water Resources Management: Realities and Challenges, .,2006.* India: Eastern Book Corpn.
2. Athavale, R. (2003). *Water Harvesting And Sustainable Supply In India.* India: Rawat Publication.
3. Dr B C Punmia, A. K. (2011). *Water Supply Engineering, Water safety in buildings.* Geneva: World Health Organization,.
4. Honore(Ed.), G. (2002). *Principles and Practices of Integrated Watershed Management in India,.* -: Indo-German Bilateral Project.
5. Iyer, R. R. (2009). *Water and the laws in India.* Chennai: Sage Publications India Pvt. Ltd,.
6. Jain, S. K. (2007). *Hydrology and Water Resources of India, Water Science and Technology Library, Vol. 57, .* New York: Springer.
7. John Briscoe, R. M. (2007). *Handbook of Water Resources in India: Development, Management, and Strategies .* Chennai :)Oxford University Press.
8. Singh, P. (2008). *Rainwater Harvesting: Low cost indigenous and innovative technologies.* India: Macmillan Publishers.

WEBSITES

1. http://www.unepfi.org/fileadmin/publications/water/chief_liquidity1_India.pdf
2. http://wrmin.nic.in
3. http://www.unicef.org/india/Final_Report.pdf

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR6511	SUSTAINABLE DESIGN STUDIO II	L	T	P	Credits	Total Marks
		0	0	15	8	300

COURSE OBJECTIVES:

- To incorporate the sustainable principles and approaches to the identified typology in the site, built form and the environment.

Studio Brief 01

6. Students shall select any one climatic zone from ECBC's climatic zone classification.
7. They shall select any city from a zone and research local bye laws and regulations.
8. They shall analyze site fit and program brief
9. They shall evaluate cultural, environmental factors and inspirations for environmental design from local vernacular and nature.
5. They shall design a residential building which shall function as per GRIHA and ECBC guidelines
6. The building should highlight at least one local material and one material which has low embodied energy as compared to conventional technology.

DELIVERABLES

4. Study report on climatic and microclimatic parameters that will guide environmental site development.
5. Study report and story board incorporating site fit, zoning and program brief, contextual adaptations from vernacular/ nature responses, conceptual design.
6. Residential typology precedent analysis
7. Preliminary energy analysis
4. Architectural documentation including 2D drawings and 3D models
5. Detailing and modelling of green building features including passive design features, hybrid features, active features, etc.
6. Detailed calculations to show energy and water savings and daylight calculations
7. Detailed embodied energy calculation
8. Final energy analysis

Studio brief 02

1. The student shall select a building type : eg Commercial/ Institutional/ Industrial-manufacturing/corporate/ Healthcare/ Hospitality
   Note: Scale of the selected building shall not be less than 5000sqm.of floor area
2. Students shall select any one climatic zone from ECBC's climatic zone classification.
3. They shall select any city from a zone and research local bye laws and regulations.
4. They shall analyze site fit and program brief
5. They shall evaluate cultural, environmental factors and inspirations for environmental design from local vernacular and nature.
5. They shall design a building which shall function as per GRIHA and ECBC guidelines
6. The building should highlight at least one local material and one material which has low embodied energy as compared to conventional technology.

DELIVERABLES

1. Detailed description of building typology selected and reasons for the same.
2. Climatic analysis and microclimatic analysis of the site.
3. A case study of a similar building in a similar climatic zone with respect to sustainability features, etc.
4. Study report and story board incorporating site fit, zoning and program brief, contextual adaptations from vernacular/ nature responses, conceptual design.
5. Preliminary energy analysis
6. Architectural documentation including 2D drawings and 3D models
7. Detailing and modelling of green building features including passive design features, hybrid features, active features, etc.
8. Detailed description of HVAC system and its sustainability feature.
9. Summary of detailed energy, water savings, daylight and embodied energy calculations and summary

COURSE OUTCOMES:

CO1: Explore the sustainable principles relevant to the design typology and the context.
CO2: Acquired knowledge on Energy conservation building code.
CO3: Ability to incorporate the sustainable principles and practices, and passive design strategies and analyze the same in the identified typology.
CO4: Develop design strategies that optimize and conserve resources and provide comfortable environment for the building occupants.
CO5: Simulating by use software tools to analyse the incorporated sustainable ideals in the emergent outcome.
CO6: Critically analyse, evaluate and make informed judgment on the working of sustainable design strategies in design.

TEXT / REFERENCE BOOKS

1. David Egan, Concepts in Thermal comfort, Prentice Hall, 1975
2. Energy Conservation Building Code of India- User manual, 2017
3. The Barefoot Architect: A Handbook for Green Building - Shelter Publication, 2007
4. Willie Weber, SimodYannas (ed.), Lessons from Vernacular Architecture, Routledge, 2013
5. ArvindKrishen, Nick Baker (ed.), Climate responsive architecture: A design handbook for energy efficient buildings, McGraw Hill Education (India) Pvt. Ltd, 1999
6. B.V Venkatarama Reddy and K.S Jagadish, Embodied energy of common and alternative building materials and technologies, Energy and Buildings, Vol. 35 2003 (pp129-137).

SARA9231	SUSTAINABLE DESIGN STUDIO II	L	T	P	Credits	Total Marks
		0	0	14	8	300
Continuous Assessment		University Viva			Min Pass Marks	
200		100			150	

COURSE OBJECTIVES:

- To incorporate the sustainable principles and approaches to the identified typology in the site, built form and the environment.
- To develop the design skills with respect to larger scale project
- To gain and apply knowledge for detailed calculations on energy and water saving.

STUDIO BRIEF 01

1. The student shall select a Campus type: Example
   Residential/ Commercial/ Institutional/ Industrial-manufacturing/Corporate/ Healthcare/ Hospitality
2. Students shall select any one climatic zone from ECBC's climatic zone classification.
3. They shall select any city from a zone and research local bye laws and regulations.
4. They shall analyse site fit and program brief
5. They shall evaluate cultural, environmental factors and inspirations for environmental design from local vernacular and nature.
5. They shall design buildings which shall function as per GRIHA and ECBC guidelines
6. The building should highlight material which has low embodied energy as compared to conventional technology and at least one sustainable building service technology in HVAC
7. The student shall design an energy model using an open source software such as eQUEST, IESVE, which gives comprehensive energy use analysis of the building.

DELIVERABLES

1. Detailed description of building typology selected and reasons for the same.
2. Climatic analysis and microclimatic analysis of the site.
3. A case study of a similar building in a similar climatic zone with respect to sustainability features, etc.
4. Study report on climatic and microclimatic parameters that will guide environmental site development.
5. Study report and story board incorporating site fit, zoning and program brief, contextual adaptations from vernacular/ nature responses, conceptual design.
6. Preliminary energy analysis and Architectural documentation including 2D drawings and 3D models
7. Detailing and modelling of green building features including passive design features, hybrid features, active features, etc.
8. Detailed calculations to show energy and water savings and daylight calculations
9. Detailed embodied energy calculation
10. Final energy analysis

STUIDO BRIEF 02

Retrofitting of building – Any Building type – Focus on building Envelope design

1. To understand Building and Climatic variables through field study analysis- measurements on-site, photos etc
2. The students will make a team andare to discover a single design strategy that will meet multiple design objectives.
3. Examine the elements in a building that mediate between the interior and exterior environment
4. To initiate energy conservation retrofits to reduce energy consumption and explore the building performance
5. To improve indoor environmental quality, decreasing moisture penetration, and reducing moldfor occupant health and productivity.
6. The design major renovations and retrofits for existing buildings should include sustainability to reduce operation costs and environmental impacts, and can increase building adaptability, durability, and resiliency.
7. They shall follow the ECBC guidelines

DELIVERABLES

1. Detailed description of building typology selected and reasons for the same.
2. Climatic analysis and microclimatic analysis of the site.
3. Case studies to understand envelope design, various measures to retrofit with respect to sustainability features, etc
4. Alternative strategies for improving thermal comfort.
5. Base case and Design case analysis
6. Final Design with details and simulations
7. Summary of detailed energy, water savings, daylight and embodied energy calculations and conclusions.

8. Report of the entire exercise as group work to be submitted.

COURSE OUTCOME:

CO1 Explore the sustainable principles relevant to the design typology and the context
CO2 Ability to incorporate the sustainable principles and practices, and passive design strategies and analyze the same in the identified typology.
CO3 Acquired knowledge on Energy models and calculations
CO4 Develop design strategies that optimize and conserve resources and provide comfortable environment for the occupants in a building
CO5 Simulating by use software tools to analyze the incorporated sustainable ideals in the emergent outcome.
CO6 Critically analyse, evaluate and make informed judgment on the working of sustainable design strategies in design.

TEXT / REFERENCE BOOKS

1. ArvindKrishen, N. B. (1999). *Climate responsive architecture: A design handbook for energy efficient buildings.* New Delhi: McGraw Hill Education (India) Pvt. Ltd,.
2. B.V Venkatarama Reddy and K.S Jagadish, s. ,. (2003). *Embodied energy of common and alternative building materials and technologie.* Vol. 35 (pp129-137): Energy and Buildings.
3. Egan, D. (1975). *Concepts in Thermal comfort.* Prentice: Prentice Hall.
4. Lengen, J. v. (2007). *The Barefoot Architect: A Handbook for Green Building .* UK: Shelter Publication.
5. Power, M. o. (2007). *Energy Conservation Building Code of India, User manual.* New Delhi: Ministry of Power.
6. Willie Weber, S. (. (2002). *Lessons from Vernacular Architecture.* -: Routledge.

SAR 5210	SUSTAINABLE URBAN PLANNING	L	T	P	Credits	Total Marks
		2	1	0	3	100

COURSE OBJECTIVE:

- To emphasize the importance of sustainable design practices and strategies in urban planning and settlement design.
- To understand the sustainable approaches in traditional settlements and the impacts of post industrial settlements.
- To explore the emerging sustainable urban design concepts and strategies.

UNIT 1 PRE HISTORIC SETTLEMENTS **12 Hrs.**

Traditional design strategies of human habitats in India and other parts of the world with special focus on resource management and built forms in response to harsh climatic conditions - Concepts and principles related to Eco-Village.

UNIT 2 POST INDUSTRIAL REVOLUTION SETTLEMENTS **12 Hrs.**

Urban pollutants and their impact on air, water, land and micro climate - Impact of built form density, building footprint, urban form including height and geometry, orientation of streets, etc. on micro climate especially light, ventilation and temperature.

UNIT 3 URBAN DESIGN STRATEGIES **12 Hrs.**

Improving environmental quality, energy efficiency, efficient resource management (soil, water, waste and materials) through appropriate site selection, effective neighbourhood planning and Urban design strategies - Transport planning, land-use zoning strategies, landscape planning etc. - Study of zero discharge sites and communities.

UNIT 4 EMERGING IDEAL AND CONCEPTS **12 Hrs.**

Concepts related to urban renewal namely inner city regeneration, revitalization of the "townships" and informal settlement / slum upgrading - Integrating renewable energy at neighbourhood scale, smart grids, concept of solar cities, smart cities, eco cities.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Understand the sustainability principles at urban scale in selected cities.
CO2: Learn traditional sustainable principles at settlement level with case examples.
CO3: Critically analyze and assess the impacts of the post-industrial urban built form on the environment
CO4: Outline the sustainable urban design strategies with case examples.
CO5: Comprehend the emerging sustainable urban design concepts and strategies.
CO6: Evaluate the suitability, strength and weaknesses of sustainable urban design strategies and concepts in different contexts.

TEXT / REFERENCE BOOKS

1. CIRIA, TheSuDs Manual, CIRIA C 697, Edited by CIRIA, London, 2007
2. Emmanuel.R., An urban approach to climate sensitive design: strategies for the tropics, Span Press, Taylor and Francis, 2005
3 Farr, Douglas, Sustainable Urbanism: Urban Design with Nature,John Wiley & Sons, 2008
4. Beatley, Timothy, Biophilic Cities: Integrating Nature into Urban Design and Planning, Island Press, 2010
5. Register, Richard, Ecocities - Rebuilding Cities in Balance with Nature, New Society Publishers, 2006

WEBSITES

1. http://www.nmun.org/ny_archives/ny13_downloads/BGGU13UNHABITAT.pdf
2. http;//Planning%20Sustainable%20Cities%20UN-HABITAT%20Practices%20and%20Perspectives.pdf
3. http://www.newurbanism.org

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA5331	SUSTAINABLE URBAN PLANNING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To emphasize the importance of sustainable design practices and strategies in urban planning and settlement design.
- To understand the sustainable approaches in traditional settlements and the impacts of post-Industrial settlements.
- To explore the emerging sustainable urban design concepts and strategies.

UNIT 1 PRE-HISTORIC SETTLEMENTS 9 Hrs.

Traditional design strategies of human habitats in India - Principles of urban planning, classifications of human settlements in pre industrial era and other parts of the world with special focus on resource management and built forms in response to harsh climatic conditions - Concepts and principles related to Eco-Village.

UNIT 2 POST INDUSTRIAL REVOLUTION SETTLEMENTS 12 Hrs.

Urban pollutants and their impact on air, water, land and micro climate - Impact of built form density, building footprint, urban form including height and geometry, orientation of streets, etc. on micro climate especially light, ventilation and temperature.

Suggestive Assignment – Evaluating the impact of urban form on climate responsiveness by reviewing journal papers

UNIT 3 URBAN DESIGN STRATEGIES 9 Hrs.

Study of national planning standards - UDPFI guidelines. Improving environmental quality, energy efficiency, efficient resource management (soil, water, waste and materials) through appropriate site selection, effective neighbourhood planning and Urban design strategies - Transport planning, land-use zoning strategies, landscape planning etc. - Study of zero discharge sites and communities.

UNIT 4 EMERGING IDEAS AND CONCEPTS 9 Hrs.

Concepts related to urban renewal namely inner-city regeneration, revitalization of the "townships" and informal settlement / slum upgrading - Integrating renewable energy at neighborhood scale, smart grids, concept of solar cities, smart cities, eco cities.

Suggestive Assignment – Critically analyze the upcoming smart city projects in India as a Group work.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Investigating our campus in an urban perspective and submitting proposal to enhance the performance of the campus – air, water and microclimate

Max. 45 Hours

COURSE OUTCOME:

CO1 Understand the sustainability principles at urban scale in selected cities.
CO2 Learn traditional sustainable principles at settlement level with case examples.
CO3 Critically analyse and assess the impacts of the post-industrial urban built form on the environment
CO4 Outline the sustainable urban design strategies with case examples.
CO5 Comprehend the emerging sustainable urban design concepts and strategies.
CO6 Evaluate the suitability, strength and weaknesses of sustainable urban design strategies and concepts in different contexts.

TEXT / REFERENCE BOOKS

1. Beatley, T. (2010). *Biophilic Cities: Integrating Nature into Urban Design and Planning* : Island Press.
2. CIRIA. (2007). *TheSuDs Manual, CIRIA.* London: CIRIA, C697.
3. Emmanuel.R. (2005). *An urban approach to climate sensitive design: strategies for the tropics.* London: Span Press,Taylor and Francis.
4. Farr, D. (2008). *Sustainable Urbanism: Urban Design with Nature.* New York,NY: John Wiley & Sons.
5. Register, R. (2006). *Ecocities, Rebuilding Cities in Balance with Nature.* Canada: New Society Publishers.

WEBSITES

1. http://www.nmun.org/ny_archives/ny13_downloads/BGGU13UNHABITAT.pdf
2. http;//Planning%20Sustainable%20Cities%20UN-HABITAT%20Practices%20and%20Perspectives.pdf
3. http://www.newurbanism.org

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5211	SUSTAINABLE WASTE MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To expose the students to the need, importance, types and management of solid waste.
- To understand the laws/ rules governing waste management and the strategies adopted in India and other countries
- To comprehend the innovative practices of utilizing waste in as resources in construction industry.

UNIT 1 INTRODUCTION TO WASTE MANAGEMENT **8Hrs.**

Introduction to waste management - Wastes generated by human habitat: solid, liquid and gaseous - Types of wastes: municipal, industrial, post-consumer, 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.

UNIT 2 SOLID WASTE MANAGEMENT IN INDIA **14Hrs.**

Cradle to Cradle cycle of municipal waste – Segregation at source, storage, transportation, disposal and processing - Waste management in India– Current scenario, challenges, responses and pitfalls - Waste management in difficult terrains: hilly areas, high rain-fall areas, water fronts, etc., - Grey water recycling in Singapore city regions.

UNIT 3 SOLID WASTE MANAGEMENT IN OTHER COUNTRIES **14Hrs.**

Overview of wastemanagement from other parts of the world - Contemporary technologies and infrastructure for waste management - Designing infrastructure for efficient and effective solid waste management from generation point to final disposal: waste bins, cold rooms, transport mechanisms, landfill sites, incinerators, composting, etc. - Designing collection system for waste in different types of building structure - Financial models for waste management - Role of NGOs in effective waste management, sanitation and health.

UNIT 4 WASTE AS A RESOURCE **12 Hrs.**

Recycling industrial, agricultural and municipal waste - Recycling waste as alternative material for buildings, landscape and other products - Study of innovative practices for use of recycled material, specifications and construction methods for using recycled waste - Demonstrative architecture and landscape using waste, vermi-composting, biological and thermal energy options - Energy from sanitary landfills, refuse derived fuel and other options.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Comprehend the various types of wastes generated in human habitats.
CO2: Construct an overview and critically analyze rules governing waste management in India and other countries.
CO3: Understand the challenges of waste management in environmentally sensitive areas in specific and diverse contexts.
CO4: Outline of contemporary technologies and infrastructure adopted for waste management.
CO5: Appreciate the ways through which the wastes are addressed as resources in various domains.
CO6: Acquire the challenges in utilizing recycled materials in construction field.

TEXT / REFERENCE BOOKS

1. William McDonough, Michael Braungart, “Cradle to Cradle: Remaking the way we make things”, North Point Press, 2002.
2. ERM.UK Municipal Solid waste Management, Study for the MMA-Vol-1 Interim Report, August-1995

WEBSITES

1. http://roing.nic.in/NHPC_Docs/EMP/EMPDocs/C12_SWM.pdf
2. http://www.indiawaterportal.org/sites/indiawaterportal.org/files/Manual%20on%20municipal%20solid%20waste%20management_%20MoUD_GOI_2000.pdf
3. http://www.tn.gov.in/dtp/publications/SWM/SWM_161to184.pdf
4. http://www.environment.tn.nic.in/SoE/images/WasteManagement.pdf
5. http://planningcommission.nic.in/reports/publications/pub95_hghpwr.pdf

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA5332	SUSTAINABLE WASTE MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To expose the students to the need, importance, types and management of solid waste.
- To understand the laws/ rules governing waste management and the strategies adopted in India and other countries
- To comprehend the innovative practices of utilizing waste in as resources in construction industry.

UNIT 1 INTRODUCTION TO WASTE MANAGEMENT 9 Hrs.

Introduction to waste management - Wastes generated by human habitat: solid, liquid and gaseous - Types of wastes: municipal, industrial, post-consumer, 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.

UNIT 2 SOLID WASTE MANAGEMENT IN INDIA 12 Hrs.

Cradle to Cradle cycle of municipal waste – Segregation at source, storage, transportation, disposal and processing - Waste management in India– Current scenario, challenges, responses and pitfalls - Waste management in difficult terrains: hilly areas, high rain-fall areas, water fronts, etc.

UNIT 3 SOLID WASTE MANAGEMENT IN OTHER COUNTRIES 9 Hrs.

Overview of waste management from other parts of the world - Contemporary technologies and infrastructure for waste management - Designing infrastructure for efficient and effective solid waste management from generation point to final disposal: waste bins, cold rooms, transport mechanisms, landfill sites, incinerators, composting, etc.Grey water recycling in Singapore city regions. Designing collection system for waste in different types of building structure - Financial models for waste management - Role of NGOs in effective waste management, sanitation and health.

UNIT 4 WASTE AS A RESOURCE 9 Hrs.

Recycling industrial, agricultural and municipal waste - Recycling waste as alternative material for buildings, landscape and other products - Study of innovative practices for use of recycled material, specifications and construction methods for using recycled waste - Demonstrative architecture and landscape using waste, vermi-composting, biological and thermal energy options - Energy from sanitary landfills, refuse derived fuel and other options.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Waste management in buildings – reducing waste disposal to the system – Sustainable approach - net zero waste buildings.

Max. 45 Hours

COURSE OUTCOMES:

CO1 Comprehend the various types of wastes generated in human habitats.
CO2 Construct an overview and critically analyze rules governing waste management in India and other countries.
CO3 Understand the challenges of waste management in environmentally sensitive areas in specific and diverse contexts.
CO4 Outline of contemporary technologies and infrastructure adopted for waste management.
CO5 Appreciate the ways through which the wastes are addressed as resources in various domains.
CO6 Acquire the challenges in utilizing recycled materials in construction field.

TEXT / REFERENCE BOOKS

1. ERM.UK. (August,1995). *Municipal Solid waste Management, Study for the MMA-Vol-1 Interim Report.* UK.
2. William McDonough, M. B. (2002). *Cradle to Cradle: Remaking the way we make things.* -: North Point Press.

WEBSITES

1. http://roing.nic.in/NHPC_Docs/EMP/EMPDocs/C12_SWM.pdf2.
2. http://www.indiawaterportal.org/sites/indiawaterportal.org/files/Manual%20on%20municipal%20solid%20waste%20management_%20MoUD_GOI_2000.pdf
3. http://www.tn.gov.in/dtp/publications/SWM/SWM_161to184.pdf
4. http://www.environment.tn.nic.in/SoE/images/WasteManagement.pdf
5. http://planningcommission.nic.in/reports/publications/pub95_hghpwr.pdf

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5622	GREEN BUILDING RATING SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To get a complete overview of various kinds of green building rating systems and how they are used in the industry.
- To understand the purpose and application of green building rating system.

UNIT 1 INTRODUCTION TO GREEN RATING SYSTEMS 10 Hrs.

History of green Rating systems- LEED, GRIHA, BREEAM, IGBC- Need and use of green rating systems - Structure of the rating systems- Market response to various rating systems- Selection of the appropriate rating system.

UNIT 2 GREEN RATING SYSTEMS IN INDIA 16 Hrs.

In-depth study of the requirements of IGBC, LEED and GRIHA rating systems - Cross comparisons between the various requirements, their intents and ability of a project to meet the requirements - Other rating systems such as Eco House, Green Mark, Green Pearl, Living Building Challenge.

UNIT 3 APPLICATION OF RATING SYSTEM REQUIREMENTS 10 Hrs.

Applying the Green rating systems in a project - Role of Green building consultant- Determining the various green points- Green Accreditation examinations.

UNIT 4 THE FUTURE OF RATING SYSTEMS 10 Hrs.

Upcoming rating systems- Auditing after rating, Material certifications and stewardships - Energy modeling and energy auditing in green building ratings - Consultancy scope and services for green rating systems.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the student will be able to

CO1: Understanding of the various green rating systems and practices across the globe and Indian Context
CO2: Critically inquire the merits and demerits of Green rating Systems, Material Certification & stewardship, and their necessity
CO3: Understanding Green Rating Systems application in projects and analytical knowledge of various green points required for projects towards achieving Green Rating
CO4: Appraising the role of a green building consultant and the process of Green accreditation examination.
CO5: Analyzing and evaluating the basics of energy modelling and auditing.
CO6: Outlining the consultancy scope and services for green rating systems.

TEXT / REFERENCE BOOKS

1. Linda Reeder,Guide to Green Building Rating Systems: Understanding LEED, Green Globes, 2010
2. Jerry Yudelson, The Green Building Revolution, Island Press, 2007
3. Guide to Green Building Rating Systems: Understanding LEED, Green Globes, Energy Star, the National Green Building Standard, and More (Wiley Series in Sustainable Design) Paperback – 16 Apr 2010, by Linda Reeder

WEBSITES

1 www.usgbc.org
2. www.igbc.org
3. www.grihaindia.org
4. living-future.org/lbc

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA5333	GREEN BUILDING RATING SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To get a complete overview of various kinds of green building rating systems and application in the industry.
- To understand the purpose, benefits and application of green building rating system.
- To enable students to evaluate the type of green rating system most suitable for a particular project

UNIT 1 INTRODUCTION TO GREEN RATING SYSTEMS 9 Hrs.

History of green Rating systems- LEED, GRIHA, BREEAM, IGBC- Need and use of green rating systems - Structure of the rating systems- Design parameters that affect Green building ,Market response to various rating systems

UNIT 2 GREEN RATING SYSTEMS IN INDIA 12 Hrs.

In-depth study of the requirements of IGBC, LEED and GRIHA rating systems - Cross comparisons between the various requirements, their intents and ability of a project to meet the requirements - Other rating systems such as Eco House, Green Mark, Pearl, Living Building Challenge, Selection of the appropriate rating system for project.

UNIT 3 APPLICATION OF RATING SYSTEM REQUIREMENTS 9 Hrs.

Applying the Green rating systems in a project – Calculations involved in rating system, Role of Green building consultant- Determining the various green points- Green Accreditation examination and the procedure to apply

UNIT 4 THE FUTURE OF RATING SYSTEMS 9 Hrs.

Upcoming rating systems- Auditing after rating, Material certifications and stewardships, Audit - Green Audit, Energy modeling and energy auditing in green building ratings - Consultancy scope and services for green rating systems.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Exploring and documenting case studies on Green Buildings highlighting various techniques and strategies adopted to achieve credits for LEED and GRIHA rated buildings. Preparing document for evaluating important credits that can be adopted to achieve

Max.45 Hours

COURSE OUTCOME:

CO1 Understanding of the various green rating systems and practices across the globe and Indian Context
CO2 Critically inquire the merits and demerits of Green rating Systems, Material Certification & stewardship, and their necessity
CO3 Understanding Green Rating Systems application in projects and analytical knowledge of various green points required for projects towards achieving Green Rating
CO4 Appraising the role of a green building consultant and the process of Green accreditation examination.
CO5 Analyzing and evaluating the basics of energy modelling and auditing.
CO6 Outlining the consultancy scope and services for green rating systems.

TEXT / REFERENCE BOOKS

1. Micheal Bauer, Peter Mosle, Micheal Schwarz (2010), Green building guide book for Sustainabe Architecture, Springer
2. Sam Kubba, (2012). Handbook of Green building design and construction, Elsevier Inc
3. Reeder, L. (2010). *Guide to Green Building Rating Systems: Understanding LEED, Green Globes, Energy Star, the National Green Building Standard, and More.* (Wiley Series in Sustainable Design).
4. Yudelson, J. (2007). *The Green Building Revolution.* Island Press.

WEBSITES

1. www.usgbc.org
2. www.igbc.org
3. www.grihaindia.org
4. living-future.org/lbc

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

S89 INT	PROFESSIONAL TRAINING	L	T	P	Credits	Total Marks
		0	0	0	5	200

COURSE OBJECTIVES:

- To undergo professional training in a firm to get experience of handling various environmental design practice.
- To utilize the forum to discuss key issues in the projects, keep track of the different sustainable approaches, communicate with the stakeholders and get an overall view of the contract administration.
- The final project report will comprise of an in-depth research and analysis of activities in the form of drawings & relevant details, schematic charts & reports, photographs, documentation of the project, comments, suggestions, etc to appraise the efficiency in progress of work.

The candidate has to join an architectural or environmental design practice and work on the design/ documentation of a sustainable architecture, environmental site planning project for a minimum of 30 working days during their summer vacation. A comprehensive report shall be submitted at the end of the summer internship.

COURSE OUTCOMES:

On completion of the course the students will be able to
CO1: Apply the knowledge and skills acquired in the classroom to a professional context.
CO2: Demonstrate an enhanced knowledge about practical aspects of the field.
CO3: Develop professional skills from green consultant for various green rating system.
CO4: Ability to prepare a portfolio of the academic and professional design work.

S89APT	PROFESSIONAL TRAINING	L	T	P	Credits	Total Marks
		0	0	0	3	300

Continuous Assessment	University Viva	Min Pass Marks
50	50	50

COURSE OBJECTIVES:

- To undergo professional training in a firm to get experience of handling various environmental design practice, Sustainable developments and learn latest software trending in the market.
- To utilize the forum to discuss key issues in the projects, keep track of the different sustainable approaches, communicate with the stakeholders and get an overall view of the contract administration.
- The final project report will comprise of an in-depth research and analysis of activities in the form of drawings & relevant details, schematic charts & reports, photographs, documentation of the project, comments, suggestions, etc to appraise the efficiency in progress of work.

PROCEDURE

1. The candidate has to join an Architectural or Environmental design practice or organization and work on the design/ documentation of projects related to Sustainable Architecture and or Environmental site planning projects for a minimum of 30 working days during their summer vacation.
2. Weekly report has to be sent to the concerned Year Coordinator by the student duly signed by the head of the firm, which needs to be compiled in the comprehensive report later.
3. This comprehensive report shall be submitted at the end of the summer internship along with the Joining letter and experience letter.
4. The evaluation of report and viva voce examination shall be conducted as per norms for the Institution Semester examination.

COURSE OUTCOME:

CO1 Accumulate concepts or skills with access to leading experts with specialized knowledge and experience.
CO2 Obtain enhanced knowledge, develop communication skills and learn practical application aspects in the field.
CO3 Manage projects using proven, effective performance measurement techniques.
CO4 Analyze and recommend project decisions concerning scope, design, cost and other project parameters faster, effectively and confidently.
CO5 Ability to prepare a portfolio of the academic and professional design work.
CO6 Develop knowledge of the new software, materials, costing and documentation prevalent in Sustainable Architecture projects.

S89 PROJ1	PRE THESIS	L	T	P	Credits	Total Marks
		0	0	0	4	100

COURSE OBJECTIVES:

1. To identify an area of research and design interest related to sustainable architecture and develop a thesis synopsis

The intent of pre thesis is to initiate the selection of Thesis topic in the beginning of the third semester itself. The students shall work three alternative topics by studying and analysing the published research papers of their interest area and give justification for the selection of the topics which will be assigned to him / her to proceed to the next phase.

The subject for special study conceptual or practical but pertaining to sustainable building and environment design practices.

Each student will prepare the Pre-Thesis with regular reviews by the faculty of the department. The Thesis will be presented in the accepted form of a Pre-thesis report duly supported by copious references, sketches, graphs, proposed statistical data, proposed details of survey, tools and techniques and methodology to be adopted and detailed account of experimental analytical procedures to be adopted.

Each student is required to defend his/her Pre-Thesis at a Viva Voce Examination by jury. The Pre-Thesis shall consist of literature review, literature case-study and live case-study for the topic chosen.

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Identify area of research and design interest and synthesize related theories of sustainability into a comprehensive research and design project.
CO2: Ability to collect pertinent data and evaluate relevant information independently.
CO3: Identify and critically analyze case studies
CO4: Develop architectural program for a chosen research theme.
CO5: Ability to prepare a thesis synopsis.
CO6: Facilitate the process and prepare research papers.

S89APROJ2	PRE-THESIS	L	T	P	Credits	Total Marks
		0	0	6	3	200

Continuous Assessment	University Viva	Min Pass Marks
100	100	50

COURSE OBJECTIVES

- To identify an area of research and design interest related to sustainable architecture and develop a thesis synopsis
- To facilitate the independent research skills of students
- To acquire a fresh approach in formulating an effectivemethodology that will help in the flow of the research

COURSE CONTENT

Research Content:

The intent of pre thesis is to initiate the selection of thesis topic in the beginning of the third semester itself. The students shall work three alternative topics by studying and analysing the published research papers of their interest area and give justification for the selection of the topics which will be assigned to him / her to proceed to the next phase.

The subject for special study shall be conceptual or practical but pertaining to sustainable building and environment design practices.

Research Process:

Each student will prepare the Pre-Thesis with regular reviews by the faculty of the department. The Thesis will be presented in the accepted form of a Pre-thesis report duly supported by copious references, sketches, graphs, proposed statistical data, proposed details of survey, tools and techniques and methodology to be adopted and detailed account of experimental analytical procedures to be adopted.

The Pre Thesis will be presented in the accepted form of a Pre-thesis report duly supported by copious references, sketches, graphs, proposed statistical data, proposed details of survey, tools and techniques and methodology to be adopted and detailed account of experimental analytical procedures to be adopted.

Each student is required to defend his/her Pre-Thesis at a Viva Voce Examination by jury. The Pre-Thesis shall consist of literature, survey on the topic chosen in the relevant field, theoretical and or experimental work based on the literature and discussion.

Area of Research:

The subject for special study may pertain to sustainable building design, sustainable environment, climate change, carbon footprint, green technology, land use and planning, sustainable policy development, energy efficiency in buildings and more related to sustainable development.

Presentation:

The final presentation is to be in the form of state of art report and drawings.

COURSE OUTCOME:

CO1 Identify area of research and design interest and synthesize related theories of sustainability into a comprehensive research and design project

CO2 Ability to collect, organize and interpret pertinent data, analyse and evaluate relevant information independently.

CO3 Acquire knowledge about various methods to research and perform qualitative and quantitative analysis.

CO4 Understanding of professional commitment to quality, timeliness, and continuous improvement.

CO5 Demonstrate good communication skills, ability to prepare and publish research papers.

TEXT / REFERENCE BOOKS

1. Ranjith Kumar (2005.) *Research Methodology- A step by step guide for beginners*, California : Sage Publications.
2. John W Creswell, (2002). *Research design: Qualitative, Quantitative and Mixed method approaches.* California : Sage Publications,.
3. Kate Turabian. (2018) *A Manual for Writers of Research Papers, Theses, and Dissertations.* Chicago:Chicago Guides to Writing, Editing, and Publishing.
4. Paola Sassi(2006) *Strategies for Sustainable Architecture: Taylor*& Francis
5. Carl Stein (2010) *Greening Modernism: Preservation, Sustainability, and the Modern Movement,* New York : W.W. Norton & Co.

SAR 5212	ENVIRONMENTAL IMPACT ASSESSMENT TECHNIQUES	L	T	P	Credits	Total Marks
		2	1	0	3	100

COURSE OBJECTIVES:

- To introduce the various aspects of environmental impact assessment.
- To understand the components and impacts of EIA and socio economic systems.
- To give an insight to sectoral EIA in diverse contexts.

UNIT 1 INTRODUCTION **8 Hrs.**

Historical development of environmental impact assessment (EIA) - EIA in project cycle, legal and regulatory aspects in India – Types and limitations of EIA – Cross sectoral issues and terms of reference in EIA – Public Participation in EIA - EIA process, screening, scoping, setting, analysis, mitigation.

UNIT 2 COMPONENTS AND METHODS **14Hrs.**

Matrices – Networks – Checklists – Connections and combinations of processes - Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA – Prediction tools for EIA – Mathematical modelling for impact prediction – Assessment of impacts: air, water, soil, noise, biological — Cumulative Impact Assessment – Documentation of EIA findings, planning, organization of information and visual display materials – Report preparation - EIA methods in other countries.

UNIT 3 IMPACT ON SOCIO-ECONOMIC SYSTEMS **14Hrs.**

Definition of social impact assessment - Social impact assessment model and the planning process - Rationale and measurement for SIA variables - Relationship between social impacts and change in community and institutional arrangements - Individual and family level impacts - Communities in transition - Neighbourhood and community impacts, selecting, testing and understanding significant social impacts - Mitigation and enhancement in social assessment - Environmental costing of projects.

UNIT 4 SECTORAL EIA **12 Hrs.**

Ethical and Quality aspects of environmental impact assessment, sectoral EIA -EIA related to the following sectors – Infrastructure, construction and housing, mining, industrial, thermal power, river valley and hydroelectric, coastal projects-Nuclear Power, hill area development and CRZ -EIA for coastal projects.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Explore about the legal and regulatory aspects overview of EIA in India.
CO2: Understanding of the components, methods, tools and documentation involved in EIA.
CO3: Analyse the impact of socio-economic systems and an insight to EIA methods in other countries.
CO4: Acquire knowledge about the various parameters in social impact assessment with examples.
CO5: Categorizing the ethical and quality aspects of EIA.
CO6: Identify the aspects and issues related to various sectoral EIA ranging from micro to macro level.

TEXT / REFERENCE BOOKS

1. Lawrence D.P., Environmental Impact Assessment – Practical solutions to recurrent problems,Wiley-Interscience, New Jersey, 2003
2. Environmental Assessment Source book-Vol. III: Guidelines for environmental assessment of energy and industry projects, World Bank,1998
3. Petts J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science, London, 1999
4. Canter L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
5. Nick Harvey, Beverley Clarke, Environmental Impact Assessment: Procedures and Practices,Oxford University Press, USA, 2012

WEBSITES

1. https://www.cbd.int/doc/nbsap/EIA/India.pdf
2. http://coe.mse.ac.in/Guidelines.asp
3. http://www.planning.nsw.gov.au/rdaguidelines/documents/emp_guideline_publication_october.pdf
4. http://www.gpcb.gov.in/pdf/Nuclear_Power_Corpo_of_India_Exe_Summ_Eng.pdf
5. http://www.tnpcb.gov.in/pdf/EIA_Perambalur_%20SEZ%20Eng.pdf
6. https://www.env.go.jp/earth/coop/coop/document/10-eiae/10-eiae-2.pdf

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA5431	ENVIRONMENTAL IMPACT ASSESSMENT TECHNIQUES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To introduce the various aspects of environmental impact assessment.
- To understand the components and impacts of EIA and socio-economic systems.
- To give an insight to sectoral EIA in diverse contexts.

UNIT 1 INTRODUCTION 9 Hrs.

Historical development of environmental impact assessment (EIA) - EIA in project cycle, legal and regulatory aspects in India – Types and limitations of EIA – Cross sectoral issues and terms of reference in EIA – Public Participation in EIA - EIA process, screening, scoping, setting, analysis, mitigation.

UNIT 2 COMPONENTS AND METHODS 10 Hrs.

Matrices – Networks – Checklists – Connections and combinations of processes - Cost benefit analysis – Analysis of alternatives – Software packages for EIA – Expert systems in EIA – Prediction tools for EIA – Mathematical modelling for impact prediction – Assessment of impacts: air, water, soil, noise, biological — Cumulative Impact Assessment – Documentation of EIA findings, planning, organization of information and visual display materials – Report preparation - EIA methods in other countries.

UNIT 3 IMPACT ON SOCIO-ECONOMIC SYSTEMS 10 Hrs.

Definition of social impact assessment - Social impact assessment model and the planning process - Rationale and measurement for SIA variables - Relationship between social impacts and change in community and institutional arrangements - Individual and family level impacts - Communities in transition - Neighborhood and community impacts, selecting, testing and understanding significant social impacts - Mitigation and enhancement in social assessment - Environmental costing of projects.

UNIT 4 SECTORAL EIA 10 Hrs.

Ethical and Quality aspects of environmental impact assessment, sectoral EIA -EIA related to the following sectors – Infrastructure, construction and housing, mining, industrial, thermal power, river valley and hydroelectric, coastal projects- Nuclear Power, hill area development and CRZ -EIA for coastal projects.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

To make a report on the role of government and government agencies in emphasizing the adoption of EIA

Max.45 Hours

COURSE OUTCOME:

CO1 Explore about the legal and regulatory aspects overview of EIA in India.
CO2 Understanding of the components, methods, tools and documentation involved in EIA.
CO3 Analyse the impact of socio-economic systems and an insight to EIA methods in other countries.
CO4 Acquire knowledge about the various parameters in social impact assessment with examples.
CO5 Categorizing the ethical and quality aspects of EIA.
CO6 Identify the aspects and issues related to various sectoral EIA ranging from micro to macro level.

TEXT / REFERENCE BOOKS

1. book, E. A. (1998). *Guidelines for environmental assessment of energy and industry projects,*. Vol. III: World Bank.
2. D.P., L. (2003). *Environmental Impact Assessment – Practical solutions to recurrent problems,*. New Jersey: Wiley-Interscience.
3. J, P. (1999). *Handbook of Environmental Impact Assessment, .* London: Blackwell Science - Vol., I and II.
4. L.W, C. (1996). *Environmental Impact Assessment,*. New York: McGraw Hill,.
5. Nick Harvey, B. C. (2012). *Environmental Impact Assessment: Procedures and Practices,*. USA: Oxford University Press.

WEBSITES

1. https://www.cbd.int/doc/nbsap/EIA/India.pdf
2. http://coe.mse.ac.in/Guidelines.asp
3. http://www.planning.nsw.gov.au/rdaguidelines/documents/emp_guideline_publication_october.pdf
4. http://www.gpcb.gov.in/pdf/Nuclear_Power_Corpo_of_India_Exe_Summ_Eng.pdf
5. http://www.tnpcb.gov.in/pdf/EIA_Perambalur_%20SEZ%20Eng.pdf
6. https://www.env.go.jp/earth/coop/coop/document/10-eiae/10-eiae-2.pdf

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

S89 PROJ2	THESIS	L	T	P	Credits	Total Marks
		0	0	0	18	600

COURSE OBJECTIVES:

- To channelize the knowledge constructed on 'sustainable principles in architecture' and successful integration in the identified typology.
- The project provides students an opportunity for academic research to cultivate specialization in the areas of their own interest under the overall guidance of the faculty

COURSE CONTENT:

The Thesis Project is a final culmination of knowledge acquired by students through the course of their sustainability curriculum. Theoretical, cognitive, empirical and analytical skills pertaining to architectural sustainability will be tested during the thesis program. Students shall consider medium to large scale campus, environmental site planning, conservation, heritage districts etc.

The Proposal shall include the methodology followed, research study, proposals and guidelines for the topic.

Each student is allocated a Thesis supervisor who is responsible for academic guidance through the process. All students are encouraged to produce a publishable paper based on the Thesis material.

DELIVERABLES

- A complete thesis report including all literature and case studies, design sheets, research findings shall be submitted.

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: To explore the sustainable principles relevant to the design typology and the context.

CO2: To develop an hypothesis to be tested through the research methodology designed for the purpose with innovative insight on specific issues thereby undertaking academic research independently

CO3: To experiment further with processes such as: Research area identification; hypothesis of research topic; literature sourcing and search; aim and objective definition; formulation of methodology; data collection, analysis and result presentation; literature and live case study; compilation and inferences; research study validation through case studies, field application and simulation models; discussion of research findings; study conclusion, proposals and recommendation formulations

CO4: To analyze the incorporated sustainable ideals in the emergent outcome through various software tools.

CO5: To Critically analyze, evaluate and make informed judgment on the working of sustainable design strategies in design and substantiating the results with building model simulations

CO6: To create an environment for students to explore and appreciate the impact of past, present and future technologies on the economy, society, and the environment with due consideration climate change and carbon foot prints.

S89APROJ3	THESIS	L	T	P	Credits	Total Marks
		0	0	24	12	600

Continuous Assessment	University Viva	Min Pass Marks
400	200	300

COURSE OBJECTIVES:

- To channelize the knowledge constructed on 'sustainable principles in architecture' and successful integration in the identified typology
- The project provides students an opportunity for academic research to cultivate specialization in the areas of their own interest under the overall guidance of the faculty.
- The objective of the seminar work 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.

Research Content: The Thesis is an individual research project that is a major piece of work undertaken by the students. It is a continuation of the Pre Thesis of the previous semester. They are expected to select a topic on a live problem in the industry

or a macro-issue pertaining toSustainability in field of Architecture. The topic should be researchable and involve scientific design of a study, collection and analysis. The aim is to prepare state of art report and drawings on the chosen topic and develop hypothesis to be tested through the research methodology designed for the purpose.

The thesis proposal should include an overview of the proposed plan of work, including the general scope of your project, your basic research questions, research methodology, and the overall significance of your study. In short, the proposal should explain what to study, how to study this topic, why this topic needs to be studied.

Thesis proposals are designed to

- Justify and plan (or contract for) a research project.
- Show how your project contributes to existing research.
- Demonstrate to your advisor and committee that you understand how to conduct discipline specific research within an acceptable time-frame.
- Recommend future study areas for research.

Research Process: Students are required to test their outcome proposals through various methods, including questionnaire surveys, case studies and simulations. Students must create an innovative insight on the specific issues.
Thesis work includes processes such as: Research area identification; hypothesis of research topic; literature sourcing and search; aim and objective definition; formulation of methodology; field study planning; survey data collection, analysis and result presentation; literature study; conceptual an empirical :compilation and inference drawing; research study validation through case studies, field application and simulation models; discussion of findings of research findings; study conclusion and recommendation formulations. The progress of the Thesis work is presented and discussed by the student periodically in the classroom environment and progress monitored continuously. This work develops the comprehension and presentation skills of the students. The students are provided guidance from the faculty to channelize their thoughts.

Area of Research: The subject for special study may be may pertain to sustainable building design, sustainable environment, climate change, disaster management, green technology, land use and planning, sustainable policy development, energy efficiency in buildings , waste and water management in projects, sustainable townships, application of green building rating system to projects, and more related to sustainable development.

Presentation: The final presentation is in the form of state of art report and poster size display sheets.

COURSE OUTCOME:

CO1 To explore the sustainable principles relevant to the design typology and the context.

CO2 To 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.

CO3 To Perform 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.

CO4 To analyse the incorporated sustainable ideals in the emergent outcome through various software tools.

CO5 To critically analyse, evaluate and make informed judgment on the working of sustainable design strategiesand substantiating the results with building model simulations, proposals and recommendation formulations

CO6 To create an environment for students to explore and appreciate the impact of past, present and future technologies on the economy, society, and the environment with due consideration climate change and carbon foot prints.

SAR 5624	SUSTAINABLE LANDSCAPE PLANNING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To familiarize the history and fundamentals of landscape ecology.
- To understand the concepts and approaches by pioneers of landscape.
- To give an insight to the various aspects of landscape planning and management.

UNIT 1 LANDSCAPE ECOLOGY **12 Hrs.**

Introduction to landscape ecology – Formation of various landforms – Landforms and landscapeprocess – Pattern and structure of landscapes– Concepts of patch, corridor and matrix - Landscape dynamics and function – Topological and chorological process within landscape - Concept of landscape metrics – Understanding dynamic interaction between landscape structure and function – Ecological services of landscape - History and Ecology.

UNIT 2 LANDSCAPE PLANNING **12 Hrs.**

Relationship between man and nature – Analytical aspects of landscape - The natural and culturalsetting - Evolution of landscape planning – Concepts and projects of McHarg, Carl Steinite,Warren Manning, Augus Hills, Phil Lewis – IzankZonneveld, Ervin Zube - Landscape planning models.

UNIT 3 PROCESS IN LANDSCAPE PLANNING **12 Hrs.**

The purpose of landscape planning – Domain and context for landscape planning – Principles of planning – Procedure in landscape planning - Problem defining, goal setting, inventory and analysis - Basics of collecting and analyzing, projecting and presenting data in landscape planning, visual assessment and aesthetic dimension– Suitability analysis – Techniques for identifying preferences - Planning options – Proposing landscape plan.

UNIT 4 CASE STUDIES: LANDSCAPE MANAGEMENT **12 Hrs.**

Reclamation and restoration of derelict landscapes - Conservation and preservation of ecological fragile areas such as wetlands, creeks etc. - Conservation ordinances - Case studies on landscape regional planning - Policies and landscape - Landscape management at regional scale - Managements practices with emphasis on urban forest, urban ecology, river front development green belt - Regional open spaces, national parks, reserved forests, wet lands, coastal areas - Horticultural practices.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the student will be able to

CO1: Acquire knowledge on the history of landscape and the interaction between the landscape, structure and function.
CO2: Explore the various phases involved in landscape planning.
CO3: Ability to incorporate the various strategies explored through case studies in design.
CO4: Understand the diverse dimensions to be addressed in identifying preferences and suitability in design.
CO5: Comprehensive overview of the landscape management practices in different contexts.
CO6: An understanding of the policies of landscape and horticulture practices.

TEXT / REFERENCE BOOKS

1. Richard T.T.Formanand Michel Godron , Landscape Ecology, John Wiley & Sons, 1986
2. Tom Turner, Landscape Planning and Environmental Impact Design, UCL Press, London, 1998
3. Ervin H. Zube, Robert O Brush, JuliosG.Y.Fabos, Landscape assessment –values, perceptions, 1975
4. G. Tyler Miller Jr., Living in the Environment: Principles, Connections, and Solutions, Brooks /Cole publisher's co., 2004
5. William M. Marsh, Landscape planning – Environmental Application, John Wiley and sons Inc., 1997

WEBSITES

1. http://www.gardenwriters.org/html/meetings/presentations_11/presentations/schweyer.pdf
2. http://www.wbcsdpublications.org/cd_files/datas/business_applications/uii/pdf/SolutionsLandscapeGujarat-FullReport.pdf
3. http://sustainable landscape construction.pdf

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA7331	SUSTAINABLE LANDSCAPE PLANNING AND DESIGN	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To familiarize the fundamentals of landscape ecology, planning and management.
- To understand the various parameters involved in sustainable landscape planning.
- To develop skills to Use landscape strategies to enhance green building performance
- To give an insight into energy efficient landscape design

UNIT 1 LANDSCAPE ECOLOGY **9 Hrs.**

Introduction to landscape ecology –Landforms and landscape process – Pattern and structure of landscapes– Concepts of patch, corridor and matrix - Landscape dynamics and function – Topological and chorological process within landscape - Concept of landscape metrics – Understanding dynamic interaction between landscape structure and function – Ecological services of landscape - History and Ecology.

UNIT 2 LANDSCAPE PLANNING AND MANAGEMENT **12 Hrs.**

Principles of landscape planning- Reclamation and restoration of derelict landscapes - Conservation and preservation of ecological fragile areas such as wetlands, creeks etc., Relationship between man and nature – Analytical aspects of landscape - Evolution of landscape planning – Concepts and projects of McHarg, Carl Steinitz, Warren Manning, Ervin Zube and famous landscape planners. Case studies on landscape planning - Policies and Landscape management practices with emphasis on urban forest, urban ecology, river front development green belt - Regional open spaces, national parks, reserved forests, wet lands, coastal areas, channel networks and drainage basins.

UNIT 3 ENERGY EFFICIENT SITE PLANNING WITH LANDSCAPE **9 Hrs.**

Relationship between site features and design requirements. Site selection, siting & orientation for energy conservation. Selection & use of landscape elements for microclimatic modification, Radiation, Wind, Temperature, humidity & precipitation modification. Design of sustainable landscape features such as bioswales, bio retention ponds etc. Contemporary concepts and concerns: "Green" Architecture and energy-saving site planning and Landscape Architecture practices.

UNIT 4 PLANTS AND SUSTAINABILITY **9 Hrs.**

The role of plant material in environmental improvement such as soil conservation, slope stabilization and modification of microclimate. Planting for shelter, windbreaks and shelter belts. Understanding of plant characteristics, like texture, growth rate, form etc., Plants and sustainability, Criteria for plant selection. Planting design for various habitats such as grasslands, woodlands, sloping areas, marshes, bogs, wetlands, waterside, aquatic planting etc. Planting design and ecological considerations.

UNIT 5 COMPREHENSIVE LEARNING **6 Hrs.**

Assignment will be in the form of individual study related to landscape planning projects, to identify project that has approached environmental issues through landscape planning principles which will be presented by the student in the form of an audio-visual presentation and a report on the same.

. **Max. 45 Hours**

COURSE OUTCOME:

CO1 Acquire knowledge on the landscape ecology process, structure and function.
CO2 Explore the various concepts and phases involved in landscape planning and management
CO3 Ability to incorporate the various strategies explored through case studies in design.
CO4 Understand the diverse dimensions to be addressed in identifying preferences and suitability in design.
CO5 Evaluate the building performance by variation in the vegetation density and typology.
CO6 Illustrate an understanding of the landscape planning and design to achieve a sustainable design

TEXT / REFERENCE BOOKS

1. Ervin H. Zube, R. O. (1975). *Landscape assessment –values, perceptions.* New York: Dowden, Hutchinson & Ross.
2. Godron, R. T. (1986). *Landscape Ecology.* University of Minnesota: John Wiley & Sons.
3. Jr., G. T. (2004). *Living in the Environment: Principles, Connections, and Solutions.* -: Brooks /Cole publisher's co.
4. Marsh, W. M. (1997). *Landscape planning – Environmental Application, 5th Edition.* New Jersey: John Wiley and sons
5. Thomas W.Cook, A. M. (2011). *Sustainable Landscape Management.* New Jersey: John Wiley & Sons.
6. Turner, T. (1998). *Landscape Planning and Environmental Impact Design.* London: UCL Press.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA7332	SOCIETY, TECHNOLOGY AND ENVIRONMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To understand the relationship between various ecosystems.
- To gain knowledge about advancements in building sectors and its impact in the growing society. and train students to manage human resources effectively for better productivity.
- To widen their perspective about societal and technological changes and their effect on holistic sustainability.

UNIT 1 MAN, AND ENVIRONMENT 9 Hrs.

Early man and Society -Interventions to the environment - farming, domestication, dams, animal husbandry, buildings, rapid urbanization, depletion of forest, factories, war, climate modifications - Societal values and aspirations of man, social equity, economic viability - Importance of environment to man, dependency on environment, ecosystem and ecological cycles, feedback loops - Disruption of ecological cycles and its effects, global culture - Wealth accumulation and its impact.

UNIT 2 TECHNOLOGY AND ITS EFFECTS ON THE ENVIRONMENT 12 Hrs.

Biodiversity – relationship between technology and development of society - Technological advancements and their effects on the environment Global Warming, climate change loss of biodiversity - Advancement in building and construction technologies such as steel and concrete technologies, Development of framed structures, multi-storied buildings, large span structures, invention of plastics - Effects on the environment - Generation of waste, use of high manufacturing energy, peak oil, depletion of fossil and natural resources.

UNIT 3 DEVELOPMENT OF SUSTAINABLE TECHNOLOGIES AND ITS EFFECTS 9 Hrs.

Need for development of sustainable technologies- Current developments in sustainable technologies - New concepts in sustainable design and engineering such as new materials, pre-fabrication, composite materials, low energy materials- Importance of 3R's - waste and water recycling, Sanctuaries and bio reserves etc., - Acceptance of new technology - Issues such as labour, economic disparity, cost of new technology, etc.

UNIT 4 EMERGING TRENDS, IDEAS AND TECHNOLGIES 9 Hrs.

New fuel techniques such as biodiesel, oil from waste, nuclear power, etc. - New policies on sustainable developments, international, Indian - Changes in attitudes of sustainability, corporate sustainability practices, social sustainability ideas, newest ideas of green buildings, ecology of green buildings

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Assignments on various interventions of human in environment – Group discussion on research articles and papers on technological advancement BANE or BOON – sustainable technologies the future – assignments and discussions.

Max.45 Hrs

COURSE OUTCOME:

CO1 Recollect and understand various concepts behind the formation of society.
CO2 Understand various levels of human interventions in a society and its impact.
CO3 Outline various technological advancements and their role in development of a society
CO4 Analyze and assimilate different sustainable technologies with their advantages and disadvantages.
CO5 Comprehend various objectives of sustainable practices and their role in providing environment friendly solutions
CO6 Analyze and understand the need for sustainable technologies and its application.

TEXT / REFERENCE BOOKS

1. Birkeland, J. (2008). *Positive Development: From Vicious Circles to Virtuous Cycles through Built Environment Design.* -: Routledge.
2. Gauzin-Müller, D. (2002). *Sustainable Architecture and Urbanism: Concepts, Technologies, Examples.* -: Birkhauser Verlag AG.
3. Marten, G. G. (2001). *Human Ecology: Basic Concepts for Sustainable Development,*. London: Routledge.
4. Office of Technology Assessment, C. o. (1994). *Perspectives on the Role of Science & Technology in Sustainable Development.* -: Diane publishing.
5. Robertson, M. ((2014)). *Sustainability Principles and Practice.* London: Routledge.

WEBSITES

1. http://sts.sagepub.com/
2. http://www.cst.iisc.ernet.in/
3. http://www.springer.com/engineering/energy+technology/journal/13705

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5620	DESIGN INNOVATIONS IN SUSTAINABLE ARCHITECTURE	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To learn about the various innovations in design from a sustainable perspective.
- To critically appreciate the innovative approaches adopted by architects around the globe.
- To foster the emerging concepts of sustainability

UNIT 1 INTRODUCTION TO DESIGN INNOVATION **10 Hrs.**

Introduction to the concept of innovation - The Nature of innovation, success of an innovation, development and application of an innovation - Design signifiers and affordances - Innovation in Architecture – History of Architectural innovations.

UNIT 2 INTERNATIONAL DESIGN INNOVATIONS **14 Hrs.**

Case studies on the sustainable innovative works of- Frank Lloyd Wright, Ken Yeang, Renzo Piano, Norman Foster, GeofferyBawa, etc. - Study and analysis of implemented sustainable ideas such as earthships, passivHauz, etc.

UNIT 3 INDIAN DESIGN INNOVATIONS **14 Hrs.**

Case Studies on the sustainable architectural innovations of Laurie Baker, Architects at Auroville, Yatinpandya, Benny kuriakose, etc.

UNIT 4 FUTURE OF DESIGN INNOVATIONS **10 Hrs.**

Study of new and emerging sustainability concepts such as Fab Tree Hab, Net Zero Carbon buildings, Arcosanti, Terreform Architecture, etc.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the student will be able to

CO1: Understand the essence and various degrees of innovation.
CO2: Comprehend the various ways through which built forms are designed innovatively.
CO3: Critically appreciate the innovative approaches and construction techniques at a global level through case studies.
CO4: Compare and contrast the innovative sustainable techniques developed by architects in India.
CO5: Explore the emerging sustainable architectural concepts in today's scenario.
CO6: Understand the principles and strategies adopted in designing Net - zero buildings.

TEXT / REFERENCE BOOKS

1. The International Handbook on Innovation edited by Larisa V. Shavinina, Pergammon, 2003
2 Donald A. Norman, The Design of everyday things, Basic books, 2002
3. Ken Yeang, Eco Skyscrapers II, Images Publishing, 2011
4. Building Without Borders: Sustainable Construction for the Global Village edited by Joe Kennedy, New Society Publishers, 2004

WEBSITES

1. www.terreform.org
2. www.earthship.com
3. www.treehugger.com

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA7431	DESIGN INNOVATIONS IN SUSTAINABLE ARCHITECTURE	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To understand the concept and types of innovation in a wider context.
- To appraise the diverse strategies adopted by diverse architects with a focus on the competing logics of sustainable architecture.
- To give an insight into the 2050s scenario

UNIT 1 INTRODUCTION TO DESIGN INNOVATION 7 Hrs.

Introduction to the concept of innovation, The Nature of innovation, Types of innovations, success of an innovation, development and application of an innovation. Models of innovations, Design signifiers and affordances, Stages in the innovation life cycle.Innovation in Architecture – Chronological development of innovative directions in architectural domain, Introduction to patents, patents for applications in architecture and architectural design.

UNIT 2 INTERNATIONAL DESIGN INNOVATIONS 10 Hrs.

Introduction to the competing logics of sustainability – eco aesthetic, eco technical, eco centric, eco social, eco cultural and eco medical. Study of new and emerging sustainability concepts such as Fab Tree Hab, Net Zero Carbon buildings, Arcosanti, Terreform Architecture, etc

UNIT 3 INDIAN DESIGN INNOVATIONS 12 Hrs.

Case Studies on the sustainable architectural innovations by transnational, national organizations and hybrid actors in Indian context- Laurie Baker, Architects at Auroville, Yatinpandya, Sanjay Prakash, Ashok B.Lall, ArvindKrishan Anil Laul, Nimish Patel, Doshi, Jaisim.

UNIT 4 FUTURE SCENARIO 10 Hrs.

Future's context, Introduction to four plausible futures – Post Anthropocene, Greentocracy, and Extinction express, Humans Inc.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Various patents obtained in architectural domain, Case studies of buildings falling under the various competing logics of sustainable architecture

Max.45 Hours

COURSE OUTCOME:

CO1 Critically understand the concept and types of innovations and the significant role played in patents
CO2 Compare the strategies adopted by various architects adopting the competing logics of sustainable architecture.
CO3 Discuss the similarities amongst the six competing logics of sustainable architecture.
CO4 Construct the 'big picture' of directions adopted by architects in Indian context.
CO5 Outline the parameters that will be influencing the 2050s scenario.
CO6 Formulate unique strategies to achieve sustainability in architectural design.

TEXT / REFERENCE BOOKS

1. (ed), J. K. (2004). *Building Without Borders: Sustainable Construction for the Global Village.* New Society Publishers.
2. Arup. (2019). *Four Plausible futures.*
3. Larisa V. Shavinina (ed), ,. ,. (2003). *The International Handbook on Innovation.* Pergammon.
4. Norman, D. A. (2002). *The Design of everyday things.* Basic books.
5. Yeang, K. (2011). *Eco Skyscrapers II.* Images Publishing.

WEBSITES

1. www.terreform.org
2. www.earthship.com
3. www.treehugger.com

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5611	RENEWABLE ENERGY TECHNOLOGIES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To understand the current status of conventional energy and the need to augment renewable energy.
- To introduce the fundamentals of generating solar, wind and oceanic energy.
- To explore the other sources of renewable energy.

UNIT 1 INTRODUCTION TO RENEWABLE ENERGY **12 Hrs.**

Current energy requirements, growth in future energy requirements, Review of conventional energy resources: coal, gas and oil reserves and resources, tar sands and oil shale, nuclear energy - Need for conversion to renewable energy- Sources of renewable energy.

UNIT 2 SOLAR ENERGY **12 Hrs.**

Solar radiation: measurements and prediction - Solar thermal collectors: flat plate collectors, concentrating collectors - Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers - Conversion of heat energy into mechanical energy - Solar thermal power generation systems - Solar Photovoltaic: principle of photovoltaic conversion of solar energy, types of solar cells and fabrication - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping, power generation schemes.

UNIT 3 WIND ENERGY & OCEANIC ENERGY **12 Hrs.**

Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, betz limit - WECS: classification, characteristics, and applications - Ocean energy resources-ocean energy routes - Principles of ocean thermal energy conversion systems- Ocean thermal power plants- Principles of ocean wave energy conversion and tidal energy conversion.

UNIT 4 OTHER RENEWABLE SOURCES **12 Hrs.**

Hydropower, nuclear fission and fusion-Geothermal energy: origin, types of geothermal energy sites, site selection, geothermal power plants - Magneto-hydro-dynamic (MHD) energy conversion - Hydrogen fuel cells, algal storage, biomass, etc.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the student will be able to

CO1: Understanding the importance and need to generate renewable energy.
CO2: Comprehensive knowledge of various ways to generate solar energy.
CO3: Interpreting the various methods of solar power harnessing
CO4: Construct knowledge on the principles oceanic energy and the respective conversion.
CO5: Analyzephotovoltaic applications and methods for converting and storing renewable energy.
CO6: Explore the other types of other renewable sources of energy and the respective energy conversion.

TEXT / REFERENCE BOOKS

1. Handbook of Renewable Energy Technologyedited by Ahmed F. Zobaa, Ramesh C. Bansal
2. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000
3. L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990
4. D. A. Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press
5. Renewable Energy: Sources and Methods By Anne Maczulak

WEBSITES

1. http://www.mnre.gov.in/
2. http://www.renewableenergyworld.com/rea/tech/home

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**

SARA7432	RENEWABLE ENERGY TECHNOLOGIES	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To understand the current status of conventional energy and the need to augment renewable energy.
- To introduce the fundamentals of generating solar, wind and oceanic energy.
- To explore the other sources of renewable energy.

UNIT 1 INTRODUCTION TO RENEWABLE ENERGY 9 Hrs.

Current energy requirements, growth in future energy requirements, Review of conventional energy resources: coal, gas and oil reserves and resources, tar sands and oil shale, nuclear energy - Need for conversion to renewable energy- Sources of renewable energy.

UNIT 2 SOLAR ENERGY 10 Hrs.

Solar radiation: measurements and prediction - Solar thermal collectors: flat plate collectors, concentrating collectors - Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers - Conversion of heat energy into mechanical energy - Solar thermal power generation systems - Solar Photovoltaic: principle of photovoltaic conversion of solar energy, types of solar cells and fabrication - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping, power generation schemes.

Suggestive Assignment – Calculating the Payback period or return of investment by incorporating solar energy

UNIT 3 WIND ENERGY & OCEANIC ENERGY 10 Hrs.

Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, betz limit - WECS: classification, characteristics, and applications - Ocean energy resources-ocean energy routes - Principles of ocean thermal energy conversion systems- Ocean thermal power plants- Principles of ocean wave energy conversion and tidal energy conversion.

UNIT 4 OTHER RENEWABLE SOURCES 10 Hrs.

Hydropower, nuclear fission and fusion-Geothermal energy: origin, types of geothermal energy sites, site selection, geothermal power plants - Magneto-hydro-dynamic (MHD) energy conversion - Hydrogen fuel cells, algal storage, biomass, etc.

Suggestive Assignment – Reviewing Journal papers on renewable sources of energy and their application

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Design of a small project incorporating the renewable technologies

Max.45 Hours

COURSE OUTCOME:

CO1 Understanding the importance and need to generate renewable energy.
CO2 Comprehensive knowledge of various ways to generate solar energy.
CO3 Interpreting the various methods of solar power harnessing.
CO4 Construct knowledge on the principles of oceanic energy and the respective conversion.
CO5 Analyse photovoltaic applications and methods for converting and storing renewable energy.
CO6 Explore the other types of renewable sources of energy and the respective energy conversion.

TEXT / REFERENCE BOOKS

1. Ahmed F. Zobaa, R. C. (2002). *Handbook of Renewable Energy Technology.*
2. D. Y. Goswami, F. K. (2000). *Principles of Solar Engineering, 2000.* Philadelphia: Taylor and Francis.
3. Freris, L. (1990). *Wind Energy Conversion Systems.* Prentice Hall.
4. Maczulak, A. (2010). *Renewable Energy: Sources and Methods.* Infobase Publishing.
5. Spera, D. A. (n.d.). *Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering.* ASME Press.

WEBSITES

1. http://www.mnre.gov.in/
2. http://www.renewableenergyworld.com/rea/tech/home

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5609	ADAPTIVE REUSE AND RETROFIT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To give a comprehensive overview on how existing buildings can be adapted and retrofitted to function sustainably.
- To analyze the technologies which can be adopted for improving the energy efficiency of existing buildings
- To understand the various strategies adopted to conserve heritage buildings.

UNIT 1 SUSTAINABLE RETROFIT FOR EXISTING BUILDING

14 Hrs.

Retrofitting options for existing buildings: structural retrofit, facade, services, interior retrofit - Performance analysis of existing buildings - Physical audits - Building Simulation - Metering and tracking options - Analysis the building's current performance- Decision influencers for retrofit- economic, social and environmental issues.

UNIT 2 ADAPTIVE REUSE OF OLD BUILDING

10 Hrs.

Need for adaptive reuse - Issues to be explored in building adaption- Economic, social, environmental, and assessment models for adaptive reuse - Case studies of buildings with adaptive reuse.

UNIT 3 TECHNOLOGIES FOR ENERGY EFFICIENCY IN EXISTING BUILDINGS

12 Hrs.

Improving energy efficiency in existing buildings- Facade improvements, HVAC improvements, Indoor Environment Improvements - Monitoring the performance of retrofits - Case studies on energy efficiency improvements in existing buildings.

UNIT 4 SUSTAINABLE CONSERVATION OF HERITAGE STRUCTURES

12 Hrs.

Conservation of heritage structures - Sustainability in heritage structures - Adaptive reuse of heritage structures - Issues in adapting a heritage structure - Use of sustainable conservation techniques - Improving the energy performance of heritage structures - Case studies of sustainable conservation in heritage structures.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the student will be able to

CO1: Understanding the various types and methods of validating existing building for retrofitting.
CO2: Comprehending the ways to enhance the performance of existing building for retrofitting through audits, metering and simulation.
CO3: Interpreting the strategies adopted from various 'adaptive reuse' case studies
CO4: Critically analyzing the approaches adopted in improving the energy efficiency in different contexts.
CO5: Ability to integrate energy efficient technologies to augment the performance of existing buildings.
CO6: Exploring the issues involved in sustainable conservation of heritage structures.

TEXT / REFERENCE BOOKS

1. Sara J. Wilkinson, Hilde Remoy, Craig Langston, Sustainable Building Adaptation: Innovations in Decision-making, John Wiley and sons, 2014
2. John Krigger, Residential Energy: Cost Savings and Comfort for Existing Buildings, Prentice Hall, 2009
3. William H. Clark, Retrofitting for Energy Conservation, McGraw Hill Professional, 1997
4. Paul Apple, Sustainable Retrofit and Facilities Management, Routledge, 2013
5. ZeynepAygen,International Heritage and Historic Building Conservation: Saving the World's Past, Routledge, 2013

WEBSITES

1. http://www.wbdg.org/resources/retro_sustperf.php
2. http://www.intach.org/about-charter-guidelines.php
3. http://cpwd.gov.in/Publication/ConservationHertBuildings.pdf
4 http://www.sciencedirect.com/science/article/pii/S0378778812004227

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA7433	ADAPTIVE REUSE AND RETROFIT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To give a comprehensive overview on how existing buildings can be adapted and retrofitted to function sustainably.
- To analyze the technologies which can be adopted for improving the energy efficiency of existing buildings
- To understand the various strategies adopted to conserve heritage buildings.

UNIT 1 SUSTAINABLE RETROFIT FOR EXISTING BUILDING 9 Hrs.

Retrofitting options for existing buildings: structural retrofit, facade, services, interior retrofit - Performance analysis of existing buildings - Physical audits - Building Simulation - Metering and tracking options - Analysis the building's current performance- Decision influencers for retrofit- economic, social and environmental issues.

UNIT 2 ADAPTIVE REUSE OF OLD BUILDING 10 Hrs.

Need for adaptive reuse - Issues to be explored in building adaption- Economic, social, environmental, and assessment models for adaptive reuse - Case studies of buildings with adaptive reuse.

UNIT 3 TECHNOLOGIES FOR ENERGY EFFICIENCY IN EXISTING BUILDINGS 10 Hrs.

Improving energy efficiency in existing buildings- Facade improvements, HVAC improvements, Indoor Environment Improvements - Monitoring the performance of retrofits - Case studies on energy efficiency improvements in existing buildings.

UNIT 4 SUSTAINABLE CONSERVATION OF HERITAGE STRUCTURES 10 Hrs.

Conservation of heritage structures - Sustainability in heritage structures - Adaptive reuse of heritage structures - Issues in adapting a heritage structure - Use of sustainable conservation techniques - Improving the energy performance of heritage structures - Case studies of sustainable conservation in heritage structures.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Select a historic building (more than 100 years old) / abandoned modern building (less than 50 yearsold). Study the current state and performance of the building in terms of environment, social & economic aspects. Based on the results of the study, provide a suitable solution to improve thestructure, façade, function of the building, which in turn will reflect on the three pillars ofsustainability.

Max.45 Hours

COURSE OUTCOME:

CO1 Understanding the various types and methods of validating existing building for retrofitting.
CO2 Comprehending the ways to enhance the performance of existing building for retrofitting through audits, metering and simulation.
CO3 Interpreting the strategies adopted from various 'adaptive reuse' case studies
CO4 Critically analyzing the approaches adopted in improving the energy efficiency in different contexts.
CO5 Ability to integrate energy efficient technologies to augment the performance of existing buildings.
CO6 Exploring the issues involved in sustainable conservation of heritage structures.

TEXT / REFERENCE BOOKS

1. Sara J. Wilkinson, Hilde Remoy, Craig Langston, Sustainable Building Adaptation: Innovations in Decision-making, John Wiley and sons, 2014
2. John Krigger, Residential Energy: Cost Savings and Comfort for Existing Buildings, Prentice Hall, 2009
3. William H. Clark, Retrofitting for Energy Conservation, McGraw Hill Professional, 1997
4. Paul Apple, Sustainable Retrofit and Facilities Management, Routledge, 2013
5. ZeynepAygen,International Heritage and Historic Building Conservation: Saving the World's Past, Routledge, 2013

WEBSITES

1. http://www.wbdg.org/resources/retro_sustperf.php
2. http://www.intach.org/about-charter-guidelines.php
3. http://cpwd.gov.in/Publication/ConservationHertBuildings.pdf
4 http://www.sciencedirect.com/science/article/pii/S0378778812004227

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks
PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5605	BUILDING ENERGY ANALYSIS AND MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To achieve higher standards in building design and operation with a solid foundation of energy engineering and sustainability principles.
- To use building performance modelling as an investigative tool to improve overall energy efficiency of the building.

UNIT 1 INTRODUCTION **8 Hrs.**

Energy sources, energy demand and supply, energy crisis, future scenario, alternate sources of energy - Energy system efficiency; energy conservation aspects - Principles of energy management and energy audit - General principles, planning and program - Introduction to energy audit - General methodology, site surveys, energy systems survey, energy audit - Instrumentation and measurement, analysis of data and results.

UNIT 2 ENERGY AND BUILDING SERVICES **14 Hrs.**

Thermal performance characteristics of building elements/enclosure - Energy efficiency in design and operation of building services - Energy audit in different types of buildings and energy Management - Recycling and reuse of water products - Concepts of Green and Sustainable Buildings HVAC : Heating And Cooling Management, General principles of energy managements in HVAC systems, energy management opportunities, modeling of heating and cooling loads in buildings - Electrical load and Lighting management, General principles, illumination and human comfort; lighting systems, equipments, energy management opportunities, electrical load analysis, peak load controls - Process energy management, principles; modeling of electrical and lighting loads in buildings.

UNIT 3 INTEGRATED BUILDING SYSTEMS **10 Hrs.**

General principles, environment conformation - Passive design considerations, building envelope design consideration, integration of building system, energy storage - cold storage techniques - Economic analysis, economic aspects of energy management, general considerations - Economic analysis methods, life-cycle costing, break even analysis, benefit cost analysis, payback period analysis, present worth analysis, equivalent annual cost analysis.

UNIT 4 BUILDING INFORMATION MODELING (BIM) **16 Hrs.**

Use of computers, Building information management of energy with environment aspects - Building information modeling (BIM) - Facilitates documentation, design exploration, model-based quantity take off and estimating, interference checking, construction coordination and sequencing, digital fabrication and 3- D building information capture and visualization. - Examine geometry, spatial relationships, building information, quantities and properties of building components - Integrating people, systems, business structures and practices for maximizes efficiency through all phases of design, fabrication, construction and life cycle of the structure.

Max. 48 Hours

COURSE OUTCOMES

On completion of the course the student will be able to

CO1 : Demonstrate a broad understanding of energy sources, principles of energy management and energy auditing.
CO2 : Clearly articulate an understanding of energy efficiency in design and operation of building services.
CO3 : Develop an integrated building system approach to energy management using passive design techniques.
CO4 : Demonstrate the advanced ability to critically analyze the feasibility of energy efficient systems through economicanalysis methods,
CO5 : Generate a building energy information, performance and analysis model using energy simulation software tools.

TEXT / REFERENCE BOOKS

1. Koenigsberger, O.H, Ingersoll, T. G., Mayhew. A, Szokolay.S.V, Manual of Tropical Housing and Building Part 1 - Climatic Design, Orient Longman Pvt. Ltd, Chennai, 2004
2. W R Murphy, G Mckay, Energy Management, Butterworth-Heinemann Ltd, 1981
3. Steve Doty and Wayne C. Turner, Energy Management Handbook, Fairmont Press, 2012
4. Clive Beggs, Energy: Management, Supply and Conservation, Routledge, 2009
5. Douglas Harris, A Guide to Energy Management in Buildings, Routledge, 2011
6. LalJayamaha, Energy-Efficient Building Systems: Green Strategies for Operation and Maintenance, McGraw-Hill Professional, 2006
7. Tarik Al-Shemmeri, Energy Audits: A Workbook for Energy Management in Buildings, Wiley, 2011

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA8201	BUILDING ENERGY ANALYSIS AND MANAGEMENT	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To introduce the need for energymanagement and energy audit in buildings.
- To achieve higher standards in building design and operation with a solid foundation of energy engineering and sustainability principles.
- To use building performance modelling as an investigative tool to improve overall energy efficiency of the building.

UNIT 1 INTRODUCTION 9 Hrs.

Energy sources - energy demand and supply, energy crisis, future scenario, Alternate sources of energy - Energy system efficiency, energy conservation aspects, Principles of Energy management and Audit - General principles, planning and program - Introduction to Energy Audit -Types and Methodology, site surveys, energy systems survey, Instrumentation and measurement, analysis of data and results.

UNIT 2 ENERGY AND BUILDING SERVICES 12 Hrs.

Thermal performance of building elements/enclosure - Energy efficiency in design and operation of building services - Energy audit in different types of buildings and energy Management - Recycling and reuse of water products - Concepts of Green and Sustainable Buildings, HVAC : Heating And Cooling Management - General principles of energy managements in HVAC systems, modeling of heating and cooling energy loads needs in buildings, Electrical load and Lighting management, General principles - illumination and human comfort, lighting systems, equipment, energy management opportunities, electrical load analysis, peak load controls - Process energy management, principles-modeling of electrical and lighting loads in buildings.

UNIT 3 BUILDING INFORMATION MODELING (BIM) 12 Hrs.

Use of computers, Building information management of energy with environment aspects - Building information modelling (BIM) - Facilitates documentation - design exploration - model-based quantity take off and estimating - interference checking - construction coordination and sequencing - digital fabrication and 3-D building information capture and visualization. - Examine geometry - spatial relationships - building information - quantities and properties of building components - Integrating people – systems - business structures and practices for maximizes efficiency through all phases of design – fabrication - construction and life cycle of the structure.

UNIT 4 INTEGRATED BUILDING SYSTEMS 6 Hrs.

General principles - environment conformation - Passive design considerations - integration of building system - energy storage - cold storage techniques - Economic analysis, economic aspects of energy management - Economic analysis methods - life-cycle costing - break even analysis - benefit cost analysis - payback period analysis - present worth analysis - equivalent annual cost analysis.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Based on understanding of above Units the students are expected to perform various simulation analysis on Energy load, life cycle analysis etc., through BIM of a small project emphasizing on Energy efficiency design.

Max.45 Hours

COURSE OUTCOME:

CO1 Comprehend a broad understanding of energy sources, principles of energy management and energy auditing.
CO2 Comprehensive understanding of the thermal performance of buildings.
CO3 Acquired knowledge to demonstrate an understanding of energy efficiency in design and operation of building services.
CO4 Ability to generate a building energy information, performance and analysis model using energy simulation software tools.
CO5 Develop an integrated building system approach to energy management using passive design techniques.
CO6 Evaluate energy efficiency design through a simulation analysis approach.

TEXT / REFERENCE BOOKS

1. Clive Beggs. (2009). Energy: Management, Supply and Conservation, Routledge.
2. Douglas Harris. (2011). A Guide to Energy Management in Buildings, Routledge.
3. Koenigsberger, O.H, Ingersoll, T. G., Mayhew. A, Szokolay.S.V.(2004).Manual of Tropical Housing and Building Part 1 - Climatic Design, Orient Longman Pvt. Ltd, Chennai.
4. LalJayamaha. (2006). Energy-Efficient Building Systems: Green Strategies for Operation and Maintenance, McGraw-Hill Professional.
5. Steve Doty and Wayne C. Turner. (2012) Energy Management Handbook, Fairmont Press.
6. Tarik Al-Shemmeri (2011). Energy Audits: A Workbook for Energy Management in Buildings, Wiley.
7. W R Murphy, G Mckay.(1981).Energy Management, Butterworth-Heinemann Ltd.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**

PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks

PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SAR 5625	RESPONSIBLE COMMUNITY ACTION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE:

- To reinforce the importance of community participation as an important tool to achieve sustainability.
- To understand the relationship between human and environment.
- To reinforce the importance of community participation as an important tool to achieve sustainability
- To synthesis various parameters in creating a responsible community.

UNIT 1 MAN AND ENVIRONMENT **6Hrs.**

Relation of human with environment & climate - Concept of social structure: family, community - Traditional patterns and trends of change in Indian society.

UNIT 2 COMMUNITY AND ITS PARAMETERS **16Hrs.**

Collective action - Co-learning (sharing, facilitation), Cooperation (local people work, outsiders direct), consulting (opinions, analyses, programme) - Compliance (Assign tasks, give incentives) - Co-option (representation) - Community Mobilization: a catalyst, involvement of all stakeholders - Identification of marginalized groups like economically deprived group, women, tribal / indigenous people, disabled people, minority groups - Various platforms of community based participation.

UNIT 3 PEOPLE, SOCIETY AND SUSTAINABILITY **14Hrs.**

Design for water conservation – building and products - Designing building services, plumbing, drainage and sewerage for effective water reuse, recycling, and recharge - Strategies for water pricing and its regulations - Rain water harvesting techniques – Basic Concepts, piping techniques and pit design of groundwater recharge wells.

UNIT 4 HUMAN RESPONSES FOR SUSTAINABILITY **12 Hrs.**

Consequences of environmental degradation for people and society: health, forced relocation, attitudes and behaviour of people to mitigate environmental degradation - The initiatives by government and non government agencies to persuade people to change attitudes and behaviour to mitigate environmental degradation.

Max. 48 Hours

COURSE OUTCOMES:

On completion of the course the student will be able to

CO1: Understand the concept of social structure and its impact on the patterns, and trends of change in Indian society.

CO2: Comprehend the various aspects of collective action.

CO3: Explore the various platforms of community participation.

CO4: Synthesize the consequences of environmental degradation and the human responses to createa sustainable environment.

CO5: Understand the initiatives by government and non-governmental agencies to motivate the people in mitigating environmental degradation.

TEXT / REFERENCE BOOKS

1. Bachrach Peter andAryehBotowinick, Power and Empowerment: A Radical Theory of Participatory Democracy,: Temple University Press, 1992
2. Henry Sanoff, Community Participation Methods in Design and Planning, John Wiley and sons, 1999
3. Mark Roseland, Towards Sustainable Communities: Solutions for Citizens and their Governments, New Society Publishers, 2012

WEBSITES

1. http://nbo.nic.in/ray/comm_part_guidelines.pdf
2. http://cdf.ifmr.ac.in/wp-content/uploads/2011/08/Rajesh_LAEC_final1.pdf
3. http://www.asksource.info/cbr-book/cbr03.pdf
4. http://www.indiaurbanportal.in/reforms/state/CommunityParticipationLaw.pdf

End semester examination question paper pattern
(To be distributed uniformly among all the units)

Max. Marks: 100 **Exam Duration: 3 Hrs.**
PART A : 2 questions from each unit, each carrying 4 marks. : 08 x 05 = 40 Marks
PART B : 2 questions from each unit with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks

SARA8203	RESPONSIBLE COMMUNITY ACTION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES:

- To reinforce the importance of community participation as an important tool to achieve sustainability.
- To understand the relationship between human and environment.
- To synthesis various parameters in creating a responsible community.

UNIT 1 MAN AND ENVIRONMENT 6 Hrs.

Relation of human with environment & climate - Concept of social structure: family, community - Traditional patterns and trends of change in Indian society.

UNIT 2 COMMUNITY AND ITS PARAMETERS 12 Hrs.

Collective action - Co-learning (sharing, facilitation), Cooperation (local people work, outsiders direct), consulting (opinions, analyses, programme) - Compliance (Assign tasks, give incentives) - Co-option (representation) - Community Mobilization: a catalyst, involvement of all stakeholders - Identification of marginalized groups like economically deprived group, women, tribal / indigenous people, disabled people, minority groups - Various platforms of community based participation.

UNIT 3 SOCIETY AND WATER CONSERVATION 12 Hrs.

Design for water conservation – building and products - Designing building services, plumbing, drainage and sewerage for effective water reuse, recycling, and recharge - Strategies for water pricing and its regulations - Rain water harvesting techniques – Basic Concepts, piping techniques and pit design of groundwater recharge wells.

UNIT 4 PEOPLE AND ENVIRONMENT 9 Hrs.

Consequences of environmental degradation for people and society: health, forced relocation, attitudes and behavior of people to mitigate environmental degradation - The initiatives by government and non-government agencies to persuade people to change attitudes and behavior to mitigate environmental degradation.

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Community based group work to mitigate environmental degradation. Students are supposed to conduct literacy camps or workshops and compile a report with pictures for the same.

Max.45 Hours

COURSE OUTCOME:

CO1 Understand the concept of social structure and its impact on the patterns, and trends of change in Indian society.
CO2 Comprehend the various aspects of collective action.
CO3 Explore the various platforms of community participation.
CO4 Synthesize the consequences of environmental degradation and the human responses to createa sustainable environment.
CO5 Critical analysis of the environmental degradation
CO6 Understand the initiatives by government and non-governmental agencies to motivate the people in mitigating environmental degradation.

TEXT / REFERENCE BOOKS

1. Botowinick, B. P. (1992). *A Power and Empowerment: A Radical Theory of Participatory Democracy.* :Temple University Press.
2. Henry Sanoff. (1999). *Community Participation Methods in Design and Planning, .* John Wiley and sons.
3. Mark Roseland, s. (2012). *Towards Sustainable Communities: Solutions for Citizens and their Government.* New Society Publishers.

WEBSITES

1. http://nbo.nic.in/ray/comm_part_guidelines.pdf
2. http://cdf.ifmr.ac.in/wp-content/uploads/2011/08/Rajesh_LAEC_final1.pdf
3. http://www.asksource.info/cbr-book/cbr03.pdf
4. http://www.indiaurbanportal.in/reforms/state/CommunityParticipationLaw.pdf

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration: 3 Hrs.**

PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks : 08 x 05 = 40 Marks

PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks : 04 x 15 = 60 Marks