

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

COURSE OBJECTIVE

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

COURSE OUTCOMES:

1. Understand the sustainability principles at urban scale in selected cities.
2. Learn traditional sustainable principles at settlement level with case examples.
3. Critically analyze and assess the impacts of the post-industrial urban built form on the environment
4. Outline the sustainable urban design strategies with case examples.
5. Comprehend the emerging sustainable urban design concepts and strategies.
6. Evaluate the suitability, strength and weaknesses of sustainable urban design strategies and concepts in different contexts.

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**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 : 80****PART A : 2 questions from each unit, each carrying 4 marks.****PART B : 2 questions from each unit with an internal choice, each carrying 12 marks.****Exam Duration : 3 Hrs.****08 x 04 = 32 Marks****04 x 12 = 48 Marks**

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

COURSE OBJECTIVES

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

COURSE OUTCOMES:

1. Comprehend the various types of wastes generated in human habitats.
2. Construct an overview and critically analyze rules governing waste management in India and other countries.
3. Understand the challenges of waste management in environmentally sensitive areas in specific and diverse contexts.
4. Overview of contemporary technologies and infrastructure adopted for waste management.
5. Appreciate the ways through which the wastes are addressed as resources in various domains.
6. Learn the challenges in utilizing recycled materials in construction field.

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 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. - 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**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 : 80****PART A : 2 questions from each unit, each carrying 4 marks.****PART B : 2 questions from each unit with an internal choice, each carrying 12 marks.****Exam Duration : 3 Hrs.****08 x 04 = 32 Marks****04 x 12 = 48 Marks**

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

COURSE OBJECTIVES:

1. To give practical exposure and provide a learning opportunity for students in a professional context.

COURSE OUTCOMES:

1. Apply the knowledge and skills acquired in the classroom to a professional context.
2. Demonstrate an enhanced knowledge about practical aspects of the field.
3. Develop professional skills.
4. Ability to prepare a portfolio of the academic and professional design 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.

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

Course objectives:

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

Course Outcomes:

1. An overview of EIA, legal and regulatory aspects in India.
2. A comprehensive understanding of the components, methods, tools and documentation involved in EIA.
3. An insight to EIA methods in other countries.
4. Acquire knowledge about the various parameters in social impact assessment with examples.
5. Explore the aspects and issues related to various sectoral EIA ranging from micro to macro level.

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**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.tnpsc.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 : 80****Exam Duration : 3 Hrs.****PART A : 2 questions from each unit, each carrying 4 marks.****08 x 04 = 32 Marks****PART B : 2 questions from each unit with an internal choice, each carrying 12 marks.****04 x 12 = 48 Marks**

SAR 5601	MAINTENANCE AND REHABILITATION OF STRUCTURES	L	T	P	Credits	Total Marks
		3	0	0	3	100

Course objectives:

1. To understand the need and importance of structural maintenance, extending the serviceability and durability of structures.
2. To explore the techniques for repairing of structures, selection of suitable materials and enhancement of strength of structural elements.

Course Outcomes:

1. Understanding of the requirements for governance of good serviceability and longevity of structures.
2. Exposure to various types of engineering maintenance and evaluation of damaged structures.
3. Identify suitable materials for repair and selection of appropriate techniques to mitigate the faulty structures.
4. Knowledge about various types of special concrete to meet specific requirements of structures.
5. Identifying enhancement techniques for structural strengths of different members and knowledge about the modern demolition techniques.

UNIT 1 INFLUENCE ON SERVICEABILITY AND DURABILITY**10 Hrs.**

Effects due to climate, temperature, chemicals, wear and erosion - Design and construction errors, corrosion mechanism - Effects of cover thickness and cracking - Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection.

UNIT 2 MAINTENANCE AND REPAIR STRATEGIES**14 Hrs.**

Definitions: Maintenance, repair and rehabilitation - Facets of Maintenance importance - Maintenance Preventive measures on various aspects – Inspection - Assessment procedure for evaluating a damaged structure - Causes of deterioration - testing techniques.

UNIT 3 MATERIALS AND TECHNIQUES FOR REPAIR**14 Hrs.**

Special concretes and mortar, concrete chemicals - Special elements for accelerated strength gain, expansive cement, polymer concrete, sulphur infiltrated concrete, ferrocement, fibre reinforced concrete. Rust eliminators and polymers coating for rebars during repair foamed concrete, mortar and dry pack, vacuum concrete - Guniting and shotcrete epoxy injection, mortar repair for cracks, shoring and underpinning.

UNIT 4 EXAMPLES OF REPAIR TO STRUCTURES**10 Hrs.**

Repairs to overcome low member strength - Deflection, cracking, chemical disruption, weathering wear, fire, leakage, marine exposure - Engineered demolition techniques for dilapidated structures - Case studies

Max. 48 Hours**TEXT / REFERENCE BOOKS**

1. Denison Campbell, Allen and Harold Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical UK, 1991
2. Allen R.T. and Edwards S.C., Repair of Concrete Structures, Blahie and Sons, UK, 1993
3. Shetty M.S., Concrete Technology- Theory and Practice, Chand and Company, New Delhi, 2000
4. Verghese P.C., Maintenance, Repair & Rehabilitation & Minor Works of Buildings, Prentice Hall, 2014
5. Samuel Y. Harris, Building Pathology- Deterioration, Diagnostics and Intervention, John Wiley & sons, 2001.

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

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

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

Course Outcomes:

1. Understanding of the various green rating systems and practices across the globe and Indian Context
2. Critically inquire the merits and demerits of Green rating Systems, Material Certification & stewardship, and their necessity
3. Application of Green Rating Systems in projects and analytical knowledge of various green points required for projects towards achieving Green Rating
4. Appraising the role of a green building consultant and the process of Green accreditation examination.
5. Analyzing and evaluating the basics of energy modeling and auditing.

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**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

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

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

Course objectives:

1. To introduce the history and fundamentals of landscape ecology.
2. To understand the concepts and approaches by pioneers of landscape.
3. To give an insight to the various aspects of landscape planning and management.

Course Outcomes:

1. Acquire knowledge on the history of landscape and the interaction between the landscape, structure and function.
2. Explore the various phases involved in landscape planning.
3. Ability to incorporate the various strategies explored through case studies in design.
4. Understand the diverse dimensions to be addressed in identifying preferences and suitability in design.
5. Comprehensive overview of the landscape management practices in different contexts.
6. An understanding of the policies of landscape and horticulture practices.

UNIT 1 LANDSCAPE ECOLOGY**12 Hrs.**

Introduction to landscape ecology – Formation of various landforms – 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**12 Hrs.**

Relationship between man and nature – Analytical aspects of landscape - The natural and cultural setting - Evolution of landscape planning – Concepts and projects of McHarg, Carl Steinert, Warren Manning, Augustus Hills, Phil Lewis – Ian Lenz, 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 - 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 - Horticultural practices.

Max. 48 Hours**TEXT / REFERENCE BOOKS**

1. Richard T.T. Forman and 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, Julius G. 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.wbcsdpublishings.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**

SARA5131	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, 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%20sustainability.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**

SARA5132	BUILDING ENERGY CODES AND STANDARDS	L	T	P	Credits	Total Marks
		2	1	0	3	100

COURSE OBJECTIVES:

- To understand the importance and basics of ECBC and SP41.
- To devise the applicability of the methodologies prescribed in the codes
- To comprehend the compliance approaches

INTRODUCTION 6 Hrs.**UNIT 1**

National policies on sustainable and energy efficient development, The Energy Conservation (Amendment) Act, 2010, National policies on sustainable and energy efficient development. Introduction and Guidelines of ECBC – Energy Efficiency Performance levels, Energy Performance Index, Compliance approaches – prescriptive method, whole building performance method (Energy simulation), Compliance requirements, Building Envelope – Fenestration, opaque construction, Daylighting, building envelope sealing, Roof - Skylights, Building envelope trade off method.

UNIT 2 ECBC – COMFORT SYSTEMS AND CONTROLS 12 Hrs.

Ventilation - Minimum Space Conditioning Equipment Efficiencies -Unitary, Split, Packaged Air-Conditioners, Variable Refrigerant Flow, Air Conditioning and Condensing Units Serving Computer Rooms. Controls – Temperature control, air conditioning control, occupancy control, fan controls. Piping and duct work. System Balancing. Condensers, Service water heating, cooling towers, Economizers, Variable Flow Hydronic Systems, Energy recovery. Low-energy Comfort Systems. Lighting and controls, electrical and renewable energy systems. Calculation of energy requirements of a proposed and standard design

Suggestive Assignment – Manual calculation – lighting, fenestration efficiency calculation and lighting power allowance calculation.

UNIT 3 FUNCTIONAL EFFICIENCY OF BUILDINGS – HEAT INSULATION AND VENTILATION 12 Hrs.

SP41 – Climate, Thermal comfort, Shading devices, energy requirement for cooling and heating. Heat Insulation - introduction, terminology, requirements, heat transmission through building sections, thermal performance of building sections, orientation of buildings, building characteristics for various climates, thermal design of buildings, influence of design parameters, mechanical controls. Ventilation - introduction, terminology, ventilation requirements, minimum standards for ventilation, ventilation design, energy conservation in ventilating systems.

UNIT 4 FUNCTIONAL EFFICIENCY OF BUILDINGS - LIGHTING 9 Hrs.

Lighting –standards, general, illumination requirement, day lighting analysis, supplementary artificial lighting design, artificial lighting design, energy conservation.

Suggestive Assignment – Work out examples on thermal insulation, method of calculating solar load on vertical surfaces of different orientation, orientation on the basis of solar road

UNIT 5 COMPREHENSIVE LEARNING 6 Hrs.

Arriving at Comfort band and passive strategies for a particular city using Mahoney table, calculating overheated period and deriving the shadow mask for fenestrations

Max. 45 Hours**COURSE OUTCOME:**

- CO1** Explore about the national policies on sustainable and energy efficient development
- CO2** Understand the prescriptive method and whole building performance method.
- CO3** Analyse the available comfort systems and controls.
- CO4** Categorise the various parameters in heat insulation and ventilation.
- CO5** Acquire knowledge about the lighting requirement.
- CO6** Integrate the aspects learnt in the codes for effective application in design

TEXT / REFERENCE BOOKS

1. Bureau of Energy Efficiency, G. o. (2017). Energy Conservation Building Code. New Delhi: Bureau of Energy Efficiency.
2. Standards, B. o. (1987). SP.41 Handbook on Functional requirements of buildings. New Delhi: Bureau of Indian Standards.
2. Standards, B. o. (2016). National Building Code . India: Bureau of Indian Standards.

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

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

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

SARA6131	BUILDING PERFORMANCE ANALYSIS STUDIO	L	T	P	Credits	Total Marks
		0	1	2	3	100

COURSE OBJECTIVE:

- To introduce Simulation software like EQuest, Sefaira, Design Builder, IES VE and Envi Met and upcoming software to learn the techniques and substantiate the design.
- To understand the various simulation strategies and applications related to building sensitivity analysis, i.e. understanding the impact of equipment load in the building.
- To determine the building performance through parameters like thermal comfort of spaces, daylighting analysis, wind analysis, energy optimization and quantification.

STUDIO BRIEF**PART 1**

To understand the basics of Software through Hands-on experience and introductory parameters and their studies like Climatic analysis, Shadow analysis, volumetric zoning, mutual shading, building sensitivity analysis and material selection.

- To comprehensively study the behavior of building components through simulation strategies for better performance.
- To understand the climate responsive design strategies through daylighting analysis, solar radiation analysis, wind analysis, volumetric zoning of spaces and through performing iterations for one particular design.
- To perform Calculations and derive inferences for day lighting, ventilation and solar heat gain and loss with its analysis.
- Understanding the impact of design through multiple strategies & their behaviour from multiple results to determine the optimum design solutions
- Understanding the Behaviour of Building Components-through simulation
- To determine the behaviour of building in the aspects of Energy, CO2 footprint, resources footprint, etc.

PART 2

- Understanding of Thermal Behaviour of Spaces, Calculations for thermal comfort of spaces, for various climate and conditions and its associated parameters like heat gains-losses, temperature profiles, fabric gains-losses, Ventilation etc
- Learning the Life Cycle of the Built environment through software like OpenLCA, Revit, etc.
- Add on software and Hands-on with allied and compatible software like Radiance, PMV, Solar Tool etc

COMPREHENSIVE LEARNING

Report with individual exercises for various parameters of the taught software as per break-up of module.

COURSE OUTCOME:

- CO1** Ability to investigate the performance of buildings through calculations
CO2 Understand the basics of simulation software to analyse building performance
CO3 Demonstrate skills and techniques for substantiating design through various analysis – daylighting, wind, solar radiation
CO4 Critically analyse and perform calculations, prepare graphs and analyse the thermal performance
CO5 Applying various software tools to analyse sustainability in the built environment.
CO6 Acquired knowledge on calculations for thermal comfort, Ventilation, modelling for energy performance

TEXT/ REFERENCES BOOKS

1. Help Manuals
2. Video Tutorials
3. Trainers or Expert's Guest Lectures

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 its 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 narratives and proposal for modification and enhancement of one of the cases based on the analysis.

STUDIO BRIEF 02

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

DELIVERABLES

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

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

SARA5231	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**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 COMPREHENSIVE LEARNING**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** Acquire knowledge 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

- 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,.
- Cairns Regional Council. (2011). *Sustainable Tropical Building Design- Guidelines for commercial buildings*. Cairns: Routledge.
- Fry, M. a. (1964). *Tropical Architecture in the Dry and Humid Zones*. Bestford: Londres.
- G.Z.Brown and Mark Dekay, 2. (2001). *Sun, Wind & Light : Architectural Design Strategies*. New York: John Wiley & Sons inc.
- H, K. O. (1975). *Manual of Tropical Housing and Building. Part 1: Climatic Design*. Hyderabad: Orient Blackswan.
- Ong, J.-H. B. (2007). *Tropical Sustainable Architecture - Social and Environmental Dimensions*. Routledge: Architectural Press.
- 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****PART A : 2 questions each from unit 1 to unit 4, each carrying 5 marks****PART B : 1 question each from unit 1 to unit 4 with an internal choice, each carrying 15 marks****Exam Duration: 3 Hrs.****: 08 x 05 = 40 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, I. (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

SARA5233	PERFORMANCE ANALYSIS OF BUILDINGS	L	T	P	Credits	Total Marks
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		2	0	1	3	100
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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. Giuliano Dall'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	

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 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 Corp.
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

SMTA5205	QUANTITATIVE TECHNIQUES	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVES:

- The ability to identify, reflect upon, evaluate and apply different types of information and knowledge to form independent judgments.
- Analytical, logical thinking and conclusions based on quantitative information will be the main objective of learning this subject.

UNIT 1 PROBABILITY THEORY AND STANDARD DISTRIBUTIONS**14Hrs**

Probability - Conditional Probability - Bayes Theorem - Random variables - Binomial – Poisson- Normal Distributions with Mean, Variance applications only.

UNIT 2 TESTING OF HYPOTHESIS AND DESIGN OF EXPERIMENTS**14 Hrs**

Sampling Distribution - Test based on Normal, t, Chi-square and F-distributions. Completely Randomized Design - Randomized Block Design - Latin Square Design - ANOVA.

UNIT 3 OPERATIONS RESEARCH**14 Hrs**

Introduction to OR - Linear Programming - Graphical and Simplex methods - Big M method - Two Phase method. Duality in LPP, Transportation and Assignment problems.

UNIT 4 PRODUCTION MANAGEMENT**12Hrs**

Inventory control, EOQ, Quantity Discounts, Safety stock-Replacement Theory – Simulation Models - Quality Control.

UNIT 5 COMPREHENSIVE LEARNING**6 Hrs**

Measures of central tendency - mean, median and mode- Measures of dispersion - range, mean deviation and Standard deviation- Coefficient of variation; Regression and correlation analysis

Max. 60 Hours**COURSE OUTCOMES**

- CO1** Understand the concepts of probability and its applications.
- CO2** Apply the concepts of testing of hypothesis and design of experiments.
- CO3** Learn the concept of operations research.
- CO4** Understand the nature of data collected and methods of analysis suitable for that data, presentation of the data, techniques of presenting and reporting of data collected.
- CO5** Analyze the basic ideas of production management.

TEXTS / REFERENCE BOOKS

1. Freund.J.E and Miller.I., 1994,*Probability and Statistics for Engineers*, Prentice Hall India Ltd.
2. Gupta.S.C. and Kapur.V.K., 1999, *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons.
3. Taha.H.A., 1997, *Operations Research, An Introduction*, Prentice Hall of India Ltd.
4. Gupta PK &Hira DS, 2008.*Operations Research*, S.Chand Publishers,
5. Anderson, D. R., Sweeney, D. J., Williams, T. A., Cann .I D and Cochran, J. J. (2016). *Statistics for business economics*. Nelson Education.
6. Black, K. (2014). *Business statistics: Contemporary decision making*. John Wiley & Sons.
7. Gupta, S. .(2011). *Statistical methods*. New Delhi. : Sultan Chand and Sons.
8. Gupta, S. and Kapoor, V.(2002). *Fundamentals of mathematical statistics*. New Delhi :Sultan Chand and Sons.
9. Keller, G. (2009). *Statistics for management* ,New Delhi: Cengage Learning India,
10. Levin, R. and Rubin, D. (2004) *Statistics for management*. New Delhi : Prentice- Hall of India

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

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

- The student shall select a Campus type: Example
Residential/ Commercial/ Institutional/ Industrial-manufacturing/Corporate/ Healthcare/ Hospitality
- Students shall select any one climatic zone from ECBC's climatic zone classification.
- They shall select any city from a zone and research local bye laws and regulations.
- They shall analyse site fit and program brief
- They shall evaluate cultural, environmental factors and inspirations for environmental design from local vernacular and nature.
- They shall design buildings which shall function as per GRIHA and ECBC guidelines
- 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
- 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

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

STUDIO BRIEF 02

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

- To understand Building and Climatic variables through field study analysis- measurements on-site, photos etc
- The students will make a team and are to discover a single design strategy that will meet multiple design objectives.
- Examine the elements in a building that mediate between the interior and exterior environment
- To initiate energy conservation retrofits to reduce energy consumption and explore the building performance
- To improve indoor environmental quality, decreasing moisture penetration, and reducing mold for occupant health and productivity.
- 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.
- They shall follow the ECBC guidelines

DELIVERABLES

- Detailed description of building typology selected and reasons for the same.
- Climatic analysis and microclimatic analysis of the site.
- Case studies to understand envelope design, various measures to retrofit with respect to sustainability features, etc
- Alternative strategies for improving thermal comfort.
- Base case and Design case analysis
- Final Design with details and simulations
- Summary of detailed energy, water savings, daylight and embodied energy calculations and conclusions.
- Report of the entire exercise as group work to be submitted.

COURSE OUTCOME:

- C01** Explore the sustainable principles relevant to the design typology and the context
- C02** Ability to incorporate the sustainable principles and practices, and passive design strategies and analyze the same in the identified typology.
- C03** Acquired knowledge on Energy models and calculations
- C04** Develop design strategies that optimize and conserve resources and provide comfortable environment for the occupants in a building
- C05** Simulating by use software tools to analyze the incorporated sustainable ideals in the emergent outcome.
- C06** 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.

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**

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

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.

S89APROJ1	DISSERTATION	L	T	P	Credits	Total Marks
		0	2	10	6	300
Continuous Assessment		University Viva			Min Pass Marks	
200		100			150	

COURSE OBJECTIVES:

- To give students a broad and challenging experience that will formulate their thought process by in-depth investigation, analysis and critical review of relevant materials.
- To enable their understanding, cognitive and communicative skills, critic the existing practices in Sustainable Architecture based on the current practices, new trends and technologies.
- To provide students an opportunity to cultivate specialization in the areas of their own interest and undertake academic research or develop specific sustainable design independently.

COURSE CONTENT

Research Content: The Dissertation is an individual research project that is a major piece of work undertaken by the students. At the beginning of the third semester the students are required to be associated with a firm (Architects, engineers, project managers) for a period 30 working days within which they are expected to identify the topic of interest.

The aim is to prepare state of art report on the chosen topic and develop hypothesis to be tested through the research methodology designed for the purpose. Students are required to test their outcome proposals through various methods, including questionnaire surveys or case studies or prototype models. It is encouraged that students identify topics for the Dissertation work which can be further developed into a Thesis Project. Alternatively, this Dissertation Project can be an independent research topic or developed into a detailed design. Students must create an innovative insight on the specific issues.

Research Process: Dissertation 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 and empirical : compilation and inference drawing; research study validation through case studies, field application and simulation models; discussion of research findings; study conclusion and recommendation formulations.

The progress of the Dissertation work will be presented and discussed by the student periodically in the classroom environment and the progress will be monitored continuously. This work will develop the communication and presentation skills of the students. The students will be provided guidance from the faculty to channelize their thoughts.

Area of Research: Some of the area for Dissertation are Sustainable Architecture design, land use and planning, sustainable water management, sustainable urban planning, environmental issues, energy efficiency and conservation in buildings, building envelope design, renewable energy technologies, Eco cities, HVAC and IAQ design in buildings, healthy buildings, indoor and outdoor thermal comfort, vernacular approach to building design.

Presentation and paper: The final presentation is in the form of state of art report and poster size display sheets. At the final stage all students are encouraged to produce a publishable paper based on their research.

COURSE OUTCOMES:

- CO1** Pursue an idea of research with depth of inquiry, criticality and logic and carry out an in-depth investigation of an area of building services or management that he/she is interested
- CO2** Be able to demonstrate a high level of technical understanding of the design of buildings and associated construction processes and solutions.
- CO3** Understand and reflect a broad range of Sustainable Architecture theories and the technical knowledge gained from the entire course which may include the simulations
- CO4** Enable students to integrate such knowledge and skills, together with qualities of co-operative enquiry and reflective thought, in developing design solutions
- CO5** Develop an ability to research, analyze, evaluate and discuss a wide range of environmental tools, technologies and climatic strategies applicable to the practice of Sustainable architecture.
- CO6** Propose alternative updated strategies to improve energy efficiency of buildings and reduce carbon footprint

TEXT / REFERENCE BOOKS

1. Iain Borden, Katerina Ruedi, (2000) *The Dissertation: An Architecture Student's Handbook*, MA: Architectural Press.
2. David Bergman, (2013) *Sustainable Design: A Critical Guide (Architecture Briefs) 1st Edition*: Princeton Architectural Press
3. Kainth, G. S. (2011). *Climate Change, Sustainable Development and India*. New Delhi: LAP Lambert Academic Publishing.
4. Robertson, M. (2014). *Sustainability Principles and Practice*. London: Routledge.
5. John W. Creswell (2014), *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, Sage
6. Ali Sayigh. (2013) *Sustainability, Energy and Architecture: Case Studies in Realizing Green Buildings*, Academic Press

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 effective methodology 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.

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

S89APROJ2		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 to Sustainability 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 strategies and 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.

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