Central University of Rajasthan
School of Architecture
Department of Architecture

M. Arch. (Sustainable Architecture)

Syllabus

(Approved by the School Board in June 2020)
(Approved in the 21st Meeting of the Academic Council held on 7th July, 2020)

(Applicable from AY 2020-21)

Title of the Programme: Masters of Architecture (Sustainable Architecture) Degree Titled "M.Arch. (Sustainable Architecture)"

1. **Preamble:** Buildings consume vast amounts of resources during their construction, operation, and entire life cycle. Directly or indirectly, they account for nearly half of the primary energy consumption of the nation. Emissions from making or operating buildings damage the environment, create waste disposal problems, and add to global warming. Buildings occupants can face ill-health and discomfort if the internal environment and air quality of buildings are improper.

   Thus, designing sustainable built environment both in rural as well as in the urban context is important to provide good quality of life to inhabitants and to protect the earth's environment. Architecture education in India, especially at the undergraduate level, has very little emphasis on integrating technical, economic, social, and environmental aspects to design a sustainable built environment.

   This Master's programme aims to train Architects – to understand issues associated with Sustainable Architecture, including environmental concerns, assessment methods, energy consumption, construction materials, health, economic and social concerns, and management of buildings and other construction projects in a life-cycle perspective. This program encompasses residential, commercial, and public architecture and planning of sites and layouts as well as their effect on the urban and rural built environment.

   The programme structure follows a multidisciplinary approach integrating technology, architecture, engineering, physical sciences, ecology, management, and legal framework. The course follows a modular approach offering adequate flexibility to learners to choose from a basket of courses according to their career interests.

2. **Aim:** The programme aims to produce Architects who are competent enough to combine architectural design and planning principles with modern technology and traditional community wisdom to design a sustainable project and manage the implementation of such projects.

3. **Career Options**: The course is highly relevant for Architects who want to pursue a professional career in Architectural and Planning practice, or the construction industry, or the field of rural and urban development or academics and multidisciplinary research or at policy-making levels in government and other organizations.

4. **Duration:** 4 Semesters (2 years). It is a two-year full-time program divided into four semesters.

5. **Eligibility:** Bachelor's degree in Architecture recognized by the COA with minimum 55% marks for general and 50% for SC/ST/OBC/EWS categories

6. **Admission:** Through CCMT / GATE scores / Entrance Examination of the Central University of Rajasthan.

7. Course Structure

The programme will lead to a degree - Masters in Architecture (Sustainable Architecture).

Semester 1: The first semester will provide an insight into the awareness and culture on which sustainability is based, presenting the different contexts in which it can be applied. Theory courses will cover concepts and approaches to Sustainable Development, Traditional and Historic

Architecture if different climatic zones, Climatology and Building Physics, Ecology and Environmental Management, Communication skills and concepts and strategies related to design of energy efficient, sustainable and zero emission-built environment. Historical perspectives will expose students to traditional wisdom and passive building design strategies besides retracing the history of exploitation of renewable resources. Design project course will lay emphasis on climate and built form and apply traditional community wisdom to achieve sustainable architecture.

Semester 2: Theory courses in this semester will cover Water and Waste management, Energy systems and services and their integration in architectural design, and Sustainable building materials and technology. The design project course will lay emphasis on application of modern technologies and integrated renewable energy systems to design energy efficient buildings. A Seminar course will build students research, writing and presentation skills. Elective courses will allow students to pursue their subject interests.

Semester 3: In this semester students will be exposed to legal and policy issues concerning green buildings, environmental impact assessment of projects. A basket of elective courses will allow students to choose their thrust area. Students will also write a research-based dissertation in this semester which is a 'self-study' compulsory course.

Semester 4: In the fourth and final semester students will work on a large-scale project as a Master's Design Thesis. This is largely a self-study design project course with formal classes with two or more one-week review and feedback studios as may be decided by the HoD and Dean.

(To facilitate sequential learning a programme structure is suggested for the four semesters. Students are free to take elective courses as per their choice. Depending on the prerequisites of individual courses, and other logistics there may be slight reshuffle of the sequence of courses in 2nd, 3rd and 4th semesters.)

8. Credit Framework:

The programme is designed for optimum desired number of credits. However, to obtain the Master's Degree a student must successfully complete the minimum requirements of credits as given in this document. Students can register for courses in different semesters as per provisions of the University ordinances.

9. **Learning Outcomes**: The M. Arch. (Sustainable Architecture) the program offered by the School of Architecture at CURAJ, prepares its graduates to be professionals who will be able to:

1. Demonstrate an understanding of environmental, economic, societal, and cultural aspects of sustainable development of the human settlement.
2. Appreciate the contribution of the rich heritage of India and other ancient civilizations and apply the knowledge of passive design strategies, building materials and construction technologies to create sustainable architecture
3. Effectively blend the Vernacular and traditional wisdom with modern technologies to plan and design a wide range of building typologies, large campuses, and townships in different climatic zones of India with reverence to natural resources, building materials, and the environment.
4. Engage constructively with communities using participatory approaches both in rural and urban contexts.
5. Use simulation tools for improving overall building performance during the architectural design process.

6. Appraise architectural designs and assist in the preparation of documents for green certifications and environmental clearances
7. Exhibit intellectual autonomy with humility and openness to information and ideas from different disciplines.
8. Assimilate complex ideas and communicate them effectively in professional and academic forums.
9. Work independently and collaboratively in multidisciplinary teams to manage resources, design processes, and implementation of sustainable architectural projects.

Following are the tables indicating the relationship of courses and learning outcomes:

Table 1: Core and compulsory courses for Semester 1 and 2

Program outcomes	**Core and Compulsory Courses**									
	Semester 1						Semester2			
	ARC 601	ARC 602	ARC 603	ARC 604	ARC 605	ARC 606	ARC 607	ARC 608	ARC 710	ARC 609
Outcome 1	X		X		X	X				X
Outcome 2	X	X		X	X	X	X			X
Outcome 3	X	X		X	X	X		X		X
Outcome 4					X	X				X
Outcome5				X			X			X
Outcome 6			X					X		
Outcome 7			X						X	
Outcome8									X	
Outcome 9						X			X	X

Table 2: Core and compulsory courses for Semester 3 and 4

Program outcomes	Core and Compulsory Courses				
	Semester 3				Semester 4
	ARC 701	ARC 702 Summer Project	ARC 703 Dissertation	ARC 723 Professional and Research Writing Skills"	ARC 705
Outcome 1	X		X		X
Outcome 2					X
Outcome 3					X
Outcome 4					X
Outcome 5					X
Outcome 6	X				X
Outcome 7		X	X	X	
Outcome 8		X	X	X	X
Outcome 9					X

Table 3: Electives

Program Outcomes	ARC 711	ARC 712	ARC 713	ARC 714	ARC 715	ARC 716	ARC 718	ARC 719	ARC 720	ARC 721	ARC 722
Outcome 1					X			X			
Outcome 2			X		X						
Outcome 3		X	X		X						
Outcome 4					X						
Outcome5				X							X
Outcome 6	X					X	X		X		X
Outcome 7	X	X	X	X		X	X	X			
Outcome8	X					X				X	
Outcome 9		X	X		X		X	X			X

Figure 1: Course Structure

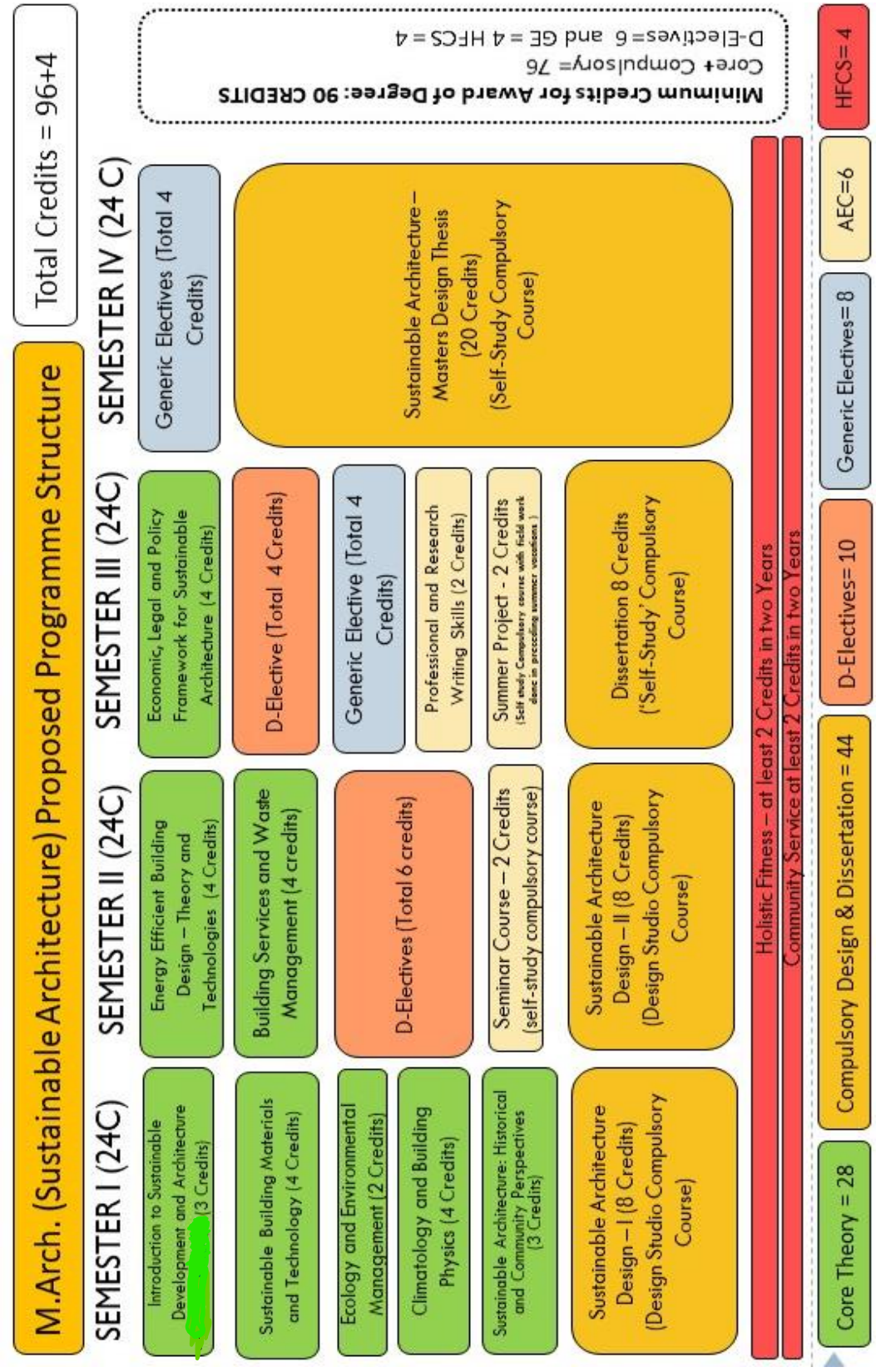

Table 4: M.Arch. (Sustainable Architecture) List of Discipline Electives

Course Code	Name of The Course	Credits
ARC 711	Research Methods in Architecture	2
ARC 712	Water Management	2
ARC 713	Sustainable Urban Transportation: Basics of Transport Planning and Design at Neighborhood Level	3
ARC 714	Renewable Energy Technologies	2
ARC 715	Sustainable Neighborhood Planning and Urban Design	3
ARC 716	Technical and Scientific Communication for Architects*	3
ARC 718	Project Management for Sustainable Architecture	3
ARC 719	Sustainable Landscape Architecture	3
ARC 720	Green Building Certification	2
ARC 721	Basic Teaching Skills for Higher Education*	3
ARC 722	Simulation and Modelling for Building Energy Performance*	2
	GIS and Remote Sensing	
	Environment Impact Assessment	

10. Scheme of Examination and Continuous Internal Assessment

The course instructor will decide the framework of formative and summative assessment for various courses for the face-to-face courses as per the following:

A. For Theory Courses

(i) Continuous Internal Evaluation (CIE) of 40 % marks consisting of:
- a. Written Test 20 %
- b. Assignment / Papers / Quiz /Presentation 20 %

(ii) End Semester Examination (EoSE) of 60% of marks. The course instructor may choose the mode of summative assessment from any of the following components:
- a. Written Examination / Quiz
- b. Formal Presentation based on literature survey or field work or primary studies / Paper(s) / Documentation on a given topic

B. For Design and project Courses

(i) Continuous Internal Evaluation (CIE) of 40% marks consisting of:
- a. Mid Semester Internal Review (20%)
- b. Mid Semester External Review (20%)

(ii) End of Semester Assessment of 60% marks consisting of
- a. End Semester Internal Jury (20%)
- b. End Semester External Jury (40 %)

C. For **Master Design Thesis**

(i) Continuous Internal Evaluation (CIE) of 40% weight consisting of:
   a. Mid Semester internal review (20%)
   b. Mid Semester external review (20%)

(ii) End Semester Assessment of 60% of marks evaluated by a Jury consisting of Internal/External experts.

D. For the **Summer Project**
& Dissertation Courses

(i) Continuous Internal Evaluation (CIE) of 40% marks consisting of:
   a. E-mentor's / faculty guide's assessment based on reporting of progress by the student in the form of synopsis and interim report(s) (15%)
   b. Review of Draft Report and Presentation (25%)

(ii) **End of Semester Assessment of 60% marks consisting of**
   a. Project Report /Dissertation evaluated by the Jury consisting of Internal / external experts (40%)
   b. Formal Presentation in person or through video conferencing before the Jury consisting of Internal / External experts (20%)

E. For **MOOC** and another short-term face to face or online courses, the evaluation shall be as per the course design and as decided by the course instructor.

11. **Unit-wise Detailed Syllabus:** The detailed syllabus is given hereafter.

Course ARC 601 (SA 1) *(Prepared and Revised by Prof. Neeraj Gupta)*

Introduction to Sustainable Development and Architecture

3 Credits L-S-T per week: 3-0-0

Pre-Requisites: Graduation in any discipline and interest in Sustainable Development, and Architecture.

Broad Objectives and Outline

As governments and societies are becoming more environmentally conscious, architects and planners are beginning to have greater concern about the built environment and its long-term viability. Given the need for conserving natural resources and the environment, expectations from professionals have increased manifold. Sustainability is, thus a critical concept and direction for the future architects and planners.

However, quite often, sustainable architecture practice is guided by architects who have not been formally trained in the environment and sustainable development. With this background, this course aims to impart an understanding of issues related to sustainable development, especially in the Indian context, that has implications on the design of buildings and neighborhoods.

Learning Outcomes:

On successful completion of the course, the students will be able to:

- Explain the concepts related to Sustainable Development and its three pillars – economic, environment, and society.
- Describe the genesis and evolution of SDGs and explain the relevance of Goals directly related to sustainable architecture
- Describe the conceptual framework of 'Systems Thinking' and 'Building as a System.'
- Demonstrate the understanding of participatory approaches to development while interacting with communities during field studies.
- Explain the influence of culture, lifestyle in shaping the sustainable built-environment with the help of examples drawn from Indian and other ancient civilizations of the world.
- Explain the concept and principles of Sustainable Architecture, and the strategies used for the passive design of energy efficient buildings in different climatic conditions that bring a paradigm change in the architectural design field.
- Comprehend overview of Green Building certification systems in India and other parts of the world.
- Assess challenges and opportunities for sustainable architecture.

Contents:

1. Overview of Sustainable Development and Systems Thinking
    a. Definitions, Genesis and historical background of Sustainable Development
    b. Overview of Sustainable Development Goals with special emphasis on
        i. Goal 5 – Gender Equality
        ii. Goal 6 – Clean Water and Sanitation
        iii. Goal 7 – Affordable and Clean Energy
        iv. Goal 11 – Sustainable Cities and Communities
    c. Understanding Systems Thinking
        i. Definition and Key Concepts
        ii. Iceberg Model
        iii. The building as a System,
2. Culture, Lifestyle, and Sustainability – Overview of Indian Culture and Ancient Cultures of the world in the context of reverence to nature, ecological systems, consumption, and energy.
3. Participatory Approaches to Development
    a. Overview and Basics of Participatory Rural Appraisal (PRA) and Participatory Learning and Action (PLA)
    b. Pretty's Typology of Participation
    c. Participatory Approaches, Methods, and Tools
4. Sustainable Architecture
    a. Definitions and Principles
    b. Environmental Impact of Buildings
    c. Sustainable Design priorities
    d. Cultural and Economic aspects
    e. Life Cycle Design
    f. Selected Examples of Sustainable Architecture – Vernacular, Historical and Contemporary
    g. Overview of passive design strategies for reducing energy consumption (enhancing user comfort while reducing or eliminating fossil fuel usage)
    h. Introduction to International and National Green Building Certification Systems

Suggestive projects / assignments / papers

- Draft a short paper highlighting contemporary local issues and concerns of sustainable development, gender perspectives, etc.
- Present a Literature Review based paper on culture, lifestyles of India and other regions of the world in the context of sustainability and energy consumption.
- Documentation of examples of sustainable architecture and human settlements and real-life projects where the focus is on climate change, clean development mechanism, use of technology, etc. may be taken.

References:

- Bob Doppelt, 2010, *The Power of Sustainable Thinking*, Earthscan, ISBN 9781849710794
- Energy Conservation and Building Code Givoni, B., 1969. *Man, Climate and Architecture*, Elsevier Publishing Company Limited.
- Koenigsberger, O. H., Ingersoll, T. G., Mayhew, A., Szokolay, S. V., 1973. *Manual of Tropical Housing and Building Part 1. Climatic* Design, Orient Longman Pvt. Ltd.
- Krishnan, A. (ed.), Baker, N., Yannas, S., Szokolay, S., 2001. *Climate Responsive Architecture – A Design Handbook for Energy Efficient Buildings*, Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Minke, Gernot and Bansal, N. K. 1988. *Climatic Zones and Rural Housing in India*, Kernforschungsanlage GmbH, Jülich.
- National Building Code
- Paul Appleby, 2010, *Integrated Sustainable Design of Buildings*, Earthscan, ISBN 9781849711173
- Scott Drake, 2009, *The Elements of Architecture - Principles of Environmental Performance in Buildings*, Earthscan, ISBN 9781844077175
- Szokolay, S. V., 2004. *Introduction to Architectural Sciences: The Basis of Sustainable Design*, Architectural Press, Oxford.
- Sen Joy, Sustainable Urban Planning TERI, ISBN 9788179933244
- TERI, 2004. *Sustainable Building Design Manual Volume 2*, prepared under a European Union co-funded ASIA-URBS project under the leadership of Institut Catala d'Energia (Spain), The Energy & Resources Institute, India.
- UNDP SDG Booklet and other Publications
  http://www.thwink.org/sustain/glossary/SystemsThinking.htm
  http://www.fao.org/docrep/006/ad424e/ad424e03.htm#TopOfPage
- Vijay Kulkarni and T V Ramachandra, Environmental Management, TERI

Course ARC 602 (SA 2) (*Revised by Ar. Ritu B Rai – Revised in January 2019)*

Sustainable Building Materials and Technology - I

4 Credits L-S-T per week: 3-2-0

Pre-Requisites: Graduation in Architecture / Civil Engineering

Broad Objectives and Outline

Sustainable building materials and technologies are being introduced in the building industry every day. It is important to understand the materials used in architecture, their physical and chemical properties, characteristics, durability, usability and performance specifications of the building systems through live case studies, workshops, lab experiments, guest lectures, hands-on exercises.

Learning outcomes:

On successful completion of the course, the students will be able to:

- Explain the use of the natural and conventional building materials which are cost-effective, environmentally friendly, and appropriate to the context of the site, climate, and culture.
- Demonstrate an understanding of the 'modern' building material developed using advanced technologies and testing methods.
- Describe the application of recycled/reconstructed building materials in the construction of green buildings.
- Describe the basic provisions of the Bureau of Indian standards related to select building material.

All students will write a paper dealing with a topic acceptable to the course instructor, and the paper must have at least five references.

Contents:

(Natural /Conventional Building materials)

1. Bamboo

a. Traditional Methods
b. Rope joints and split bamboo const.
c. Bamboo as roofing, wall, and floor material.
d. Insulation material and bamboo mats

2. Stone

a. Traditional construction technology.
b. Contemporary construction technology,

3. Mud

a. Traditional and vernacular methods in India
b. Rammed earth construction
c. Auroville construction
d. Mud/clay bricks

(Manmade /Synthetic Building Materials)

3. Hi-Tech Glass

a. Electrochemical glass
b. Nano-glass
c. Dye-sensitive glass
d. Low-e-glass
e. Other types

4. Polymers

a. Polyurethane
b. Styrene
c. Teflon
d. Epoxy floorings
e. Different vinyl

5. Prefabricated and pre-engineered buildings

6. High-performance concrete

7. Contemporary innovative building materials and their applications in Architecture.

a. Carbon Fibre Reinforced Carbon/Plastics
b. ACP & Alloys
c. Aerogels and composites

(Recycled Building Materials)

8. Alternate building materials and construction technologies

a. CLC Blocks (Cellular Light Weight Concrete)
b. Fly ash Bricks
c. AAC blocks
d. Cement Fibre boards

9. The life cycle of construction material

References:

- Bureau of Indian Standards – relevant codes.
- National Building Code of India
- Product Manufacturers' manuals/specifications
- CPWD construction manual
- Sustainability of Construction Materials, A volume in Woodhead Publishing Series in Civil and Structural Engineering *Edited by J. Khatib* ISBN: 978-1-84569-349-7

Course ARC 603 (SA 3) (*Revised by Ar. Vivekanand Tiwari – Revised in March 2020)*

Ecology and Environmental Management

2 Credits L-S-T per week: 2-0-0

Pre-Requisites: Graduation in any discipline and interest in Ecology and Environmental Studies

Broad Objectives and Outline:

With global warming and environmental protection major areas of concern across nations, environmental management course is a critical area of study for all Architects. This course thus aims to help students develop an understanding of sustainable design and development with a special concern for ecosystem benefits and impacts at the site, local, regional, and global scales.

Learning outcomes:

At the end of this course, the students will be able to

- Explain the basic concepts of Ecology and different types of ecosystems in the context of the development of human habitat.
- Describe ways of applying ecology-based principles to various areas like ecological restoration, urban areas, climate change, etc.
- Identify and analyze environmental concerns related to the built environment both in rural and urban areas and suggest ways to implement sustainable solutions.
- Describe the importance of Ecology and Environment to achieve the Sustainable Development Goals.
- Understand the trickle-down effect of ecology and environment from macro to micro level at urban and neighborhood scale.
- Explore the traditional wisdom for ecological and environmental management.
- Conceptualize the resource analysis and management in development projects with various tools and techniques.
- Understand the role of GIS and Remote Sensing in Resource Analysis, Ecological and Environmental Management
- Imply the basic concepts of ecological and environmental management at urban, regional, eco-sensitive zones.
- Apply the concept of Nature based solutions and Environmental approaches in sustainable planning and design.

Contents:

Topics to be covered:

1. Basic Concepts of Ecology and Ecosystems
   a. Ecological factors; Abiotic and Biotic
   b. Types of ecosystems, Productivity and biomass, factors affecting productivity

   c. Carrying capacity, Ecological footprints, Carbon balance
   d. Ecosystem Services
2. Neighborhood planning based on Ecology and Environment
   a. Components of neighborhood ecosystem and Factors (Water, Wind, Physiography, Soil, Geology, Vegetation, & Biodiversity) controlling neighborhood environment.
   b. Traditional wisdom and ecological management at neighborhood level.
   c. Environmental Monitoring and Resource Assessment (Tools & Techniques)
   d. Overview of EIA for large area development.
3. Basic concepts of ecological and environmental management in the selected/ identified Eco- sensitive regions of.
   a. Arid Zone
   b. Hills
   c. Coastal areas
   d. Wetlands
4. Nature based solutions and Environmental approaches for development projects
   a. Role of microclimate in habitat planning
   b. Integration of ecosystem services
   c. Attention to Soil, Physiography, Geology, Water, Vegetation and Biodiversity (SPGWVB Model) in site planning
   d. Nature based passive design strategies and development of built environment

Unit 1	Unit 2	Unit 3	Unit 4
08 Lecture	08 Lecture	04 Lecture + 02 Seminar	08 Lecture + 02 Seminar

Suggestive projects / assignments / papers / exercises

Tutorial exercises to help students understand the supportive use of mathematical modeling and computing software.

Field Project: A case study of existing settlements concerning ecology and environment – from different climatic zones of India

Paper / Assignment: Secondary source documentation of building/settlements in ecologically sensitive areas.

References:

- David Lloyd Jones, 1998, Architecture and the Environment: Bioclimatic Building Design, London: Laurence King.
- Givoni, B., 1969. *Man, Climate and Architecture*, Elsevier Publishing Company Limited.
- Minke, Gernot and Bansal, N. K. 1988. *Climatic Zones and Rural Housing in India*, Kernforschungsanlage GmbH, Jülich.
- Paul Appleby, 2010, Integrated Sustainable Design of Buildings, Earthscan, ISBN 9781849711173

- Scott Drake, 2009, The Elements of Architecture - Principles of Environmental Performance in Buildings, Earthscan, ISBN 9781844077175

Course ARC 604 (SA 4) *(Prepared by Prof. Sanjay Prakash)*

Climatology and Building Physics

4 Credits L-S-T per week: 4-0-0

Pre-Requisites: Graduation in Architecture / Science (with Physics) / Engineering

Broad Objectives and Outline

A very important component of sustainability in buildings has to do with the fact that they have to respond to the climate in which they are sited. This course aims to cover the various climates, mainly in India, and the implications of each for building design in these respective climates.
This course is closely connected to Energy Efficient Building Design and they should be in continuity, and if possible, led by the same faculty member.

Learning outcomes:

At the end of this course, the students will be able to:

- Describe the components of climate science applicable to the design of buildings and its immediate environment.
- Describe various climatic zones in India, ways to apply the information while designing buildings and identify through secondary or primary research climatically responsive features used in contemporary buildings
- Describe the basic concepts of heat transfer concerning buildings and point to strategies that need to be incorporated to achieve climatically appropriate buildings.
- Explain the concepts of psychometry and human thermal comfort and its measurement.
- Apply a basic understanding of heat transfer through buildings and calculate U values for different building skins.
- Present an understanding of basic concepts and principles of building physics that are used by building analysts and scientists.
- Describe various aspects of solar geometry and solar radiation and its application for the design of buildings.
- Explain the functions and mechanisms of ventilation

Contents:

1. Introducing Climate Science: factors such as
    a. Air temperature
    b. Air pressure
    c. Humidity
    d. Sky condition
    e. Solar radiation
    f. Night radiation
    g. Greenhouse effect
    h. Winds

i. Condensation and precipitation
j. Global warming and its effects

2. Describing Climate Zones of India:
    a. Hot and Dry
    b. Warm and Humid
    c. Moderate
    d. Composite
    e. Cold – both Humid and Dry
3. Thermal Flows (with examples drawn from building applications):
    a. Concepts of Heat Physics: Heat, Temperature, Thermal Mass and Capacity, Latent Heat
    b. Conduction
    c. Convection
    d. Radiation
    e. Evaporation
4. Psychometry:
    a. Properties of Air and Humidity, Dew Point, Saturation, Absolute Humidity, Enthalpy, Sensible and Latent Heat, Specific Volume of Air
    b. Psychrometric Chart: Familiarization with the Chart, Mapping Climate on the Chart, Mapping processes of Evaporative Cooling, Chilling, Heating, Humidification on the Chart
5. Human Thermal Comfort:
    a. Main factors affecting thermal comfort: temperature, humidity, air velocity, radiation, metabolic level, and clothing
    b. Other factors: aging, expectation, adaptive comfort
    c. Human Thermal Comfort indices: Operative Temperature, Effective Temperature, Standard Effective Temperature, Tropical Summer Index, Adaptive Comfort, Predicted Mean Vote, ASHRAE provisions
6. Steady-state Heat Transfer through Building Fabric:
    a. Thermal Transmittance, Surface Resistance, Environmental Temperature
    b. U-value
    c. Thermal Resistance of Cavities
    d. Thermal Diffusivity
    e. Sol-Air Temperature
    f. Calculation of Steady State Heat Flow
    g. Calculation of Seasonal Heating and Cooling Demand for Fixed Inside Conditions in the Steady State (Degree-Day Method)
7. Solar Geometry:
    a. Relationship of Earth and Sun
    b. Solar Movement, Sun Angles, Sun Path, Analytical and Graphical Determination, Discussion of Elliptical error, Variations of standard Time and Solar Time
    c. Solar Radiation: Measurement, Direct, Diffuse, and Global Radiation
    d. Surface properties of Materials concerning the Sun: Absorption, Transmission (for transparent surfaces), Reflection, Emissivity, and Emittance

8. Ventilation, Air Movement, and Air Change:
    a. Functions of ventilation: Health, Thermal Comfort, Structural Cooling
    b. Mechanisms for Ventilation: Natural and Created Thermal Effects, Natural, and Created Pressure Differences Forced Ventilation, Air Recirculation

Suggestive assignments and term papers:

Paper on Human Thermal Comfort / Climates of India
Concept Tests on Physics concepts during the course delivery (no books allowed)
Assignment: Case studies of Existing Buildings in India in published Literature for identifying their Climate Responsive Features

References:

- Bureau of Indian Standards, 1987. *SP41(S&T): Handbook on Functional Requirements of Buildings (Other than Industrial Buildings)*, New Delhi.
- Bureau of Indian Standards, 2005. *National Building Code of India, Part 8: Building Services, Section 1: Lighting and Ventilation*, New Delhi.
- Givoni, B., 1969. *Man, Climate, and Architecture*, Elsevier Publishing Company Limited.
- Koenigsberger, O. H., Ingersoll, T. G., Mayhew, A., Szokolay, S. V., 1973. *Manual of Tropical Housing and Building Part 1. Climatic* Design, Orient Longman Pvt. Ltd.
- Krishnan, A. (ed.), Baker, N., Yannas, S., Szokolay, S., 2001. *Climate Responsive Architecture – A Design Handbook for Energy Efficient Buildings*, Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Minke, Gernot and Bansal, N. K. 1988. *Climatic Zones and Rural Housing in India*, Kernforschungsanlage GmbH, Jülich.
- Nayak, J. K., Prajapati, J. A., 2006. *Handbook on Energy Conscious Buildings*, Prepared under the interactive R&D Project No. 3/4(03)99-SEC between Indian Institute of Technology, Bombay, and Solar Energy Centre, Ministry of New and Renewable Energy, Government of India.
- Szokolay, S. V., 2004. *Introduction to Architectural Sciences: The Basis of Sustainable Design*, Architectural Press, Oxford.
- TERI, 2004. *Sustainable Building Design Manual Volume 2*, prepared under a European Union co-funded ASIA-URBS project under the leadership of Institut Catala d'Energia (Spain), The Energy & Resources Institute, India.

Course ARC 605 (SA 5) *(Prepared by Prof. Neeraj Gupta and revised in April 2018)*

Sustainable Architecture – Historical and Community Perspectives

3 Credits **L-S-T per week: 2-2*-0** (*About 30 hours of self-learning sessions during the semester that may be spent on field study. This may include a tour to study any historic settlement)

Pre-Requisites: Graduation in any discipline and interest in Art, Architecture and Cultural Studies

Broad Objectives and Outline

The architecture of 20th century in India, barring few exceptional cases widely adopted forms, styles, and patterns seen in western architecture. Contemporary architecture in India relies on hi-techs in building materials and engineering technologies that often waste energy, and cause physical and psychological harm in varying degrees to human beings.

On the contrary, compared to modern society, ancient people were more aware of the ecological importance and had greater reverence for nature. Ancient buildings were based on natural laws and depend on natural forces to adapt to bad survival environments and improve survival conditions. Thus traditional community wisdom can provide us with rich and valuable technological experiences that can be a good reference point for modern-day architecture.

Learning outcomes:

At the end of this course, the students will be able to:

- Present a general review of concepts and principles of vernacular, and historical architecture that provide unique insights on the sustainable development of human habitat.
- Explain the practices, strategies, and implementation processes that shape sustainable architecture.
- Undertake field studies using participatory approaches while interacting with communities
- Document the vernacular and historical examples of development present them in the form of reports and presentations.
- Describe the historical and community perspectives largely from the Indian context
- Draw references from traditional community wisdom from India and other parts of the world to be applied while designing.

Topics to be covered, in detail:

1. Ancient and Historical perspectives in neighborhood planning and architecture from Vedic Culture; and other ancient cultures across the world.
2. Planning Principles of Ancient Indian cities,
3. Concepts and basic principles of Vastu-Shastra, Feng-shui (may add similar concepts from other cultures.)
4. Sustainable Architecture in history – Forts, palaces, temples, monasteries, etc. in different geo-climatic zones.

5. Human settlement Planning and Housing –Explaining examples from vernacular and planned cities.
6. The climatic response of vernacular architecture – demonstrating analytical studies, including developing scientific evidence.
7. Documentation of a rural/urban community using participatory approaches, methods, and tools.

Suggestive assignments / field study / papers:

Paper(s) on Ancient Human Settlements / Community Architecture
Assignment / Field Study: Visit a community in a group of 3-4 and using Participatory Learning and Action (PLA) approaches understand survival strategies of communities and document them in any medium of choice.

References:

- Kanji N.and Greenwood L.(2001) 'Participatory approaches to research and development in IIED: Learning from experience,' IIED: London
- Acharya P. K. 1933, 'Architecture of Mansara,' Oxford University press- Bombay Ch.5, p - 17.
- Matsya Purana. 1972. B.C. Majumdar and another Oriental publisher, Delhi, Ch.253, p-293.
- Begde Prabhakar V. 1977, Ancient and Medieval Town planning in India, Sagar Publication-New Delhi, Ch.8, p - 81-100.
- Energy Efficient buildings in India by Mili Majumdar (Teri)
- Updated scholarly papers related to sustainable architecture practices in India and around the word.
- Updated articles on contemporary buildings inspired from ancient Indian constructions techniques should be explored

Course ARC 606 (DSA 1)

Sustainable Architecture Design

8 credits **L-S-T per week: 1-8-0[#]**

Pre-Requisites: Graduation in Architecture

There will be at least two studio exercises in this course. The first exercise will involve an understanding of local culture, social aspects of development, and wisdom of traditional and vernacular architecture. For this, students will study a rural/urban community using participatory approaches or undertake documentation of old town or any historic building(s).

The course coordinator may design the second exercise to adequately cover the application of various theory subjects taught during the semester, which may be an extension of the first exercise with a deeper study of any chosen dimension of sustainable architecture or a new documentation exercise or simulation of existing building designs. It could also be a small design that blends traditional wisdom with modern technologies in the contemporary context.

Note: To ensure complete harmony between theory subjects and design studio exercises, course instructors of the theory subjects shall be part of the design studio faculty team. Such faculty members will provide regular subject related inputs and periodically review the design efforts of the students in their specific context.

Learning outcomes:

At the end of this course, the students will be able to:

- Present a document of field studies that reflect local culture, vernacular and historic architecture and sensitivity to ecology and environment
- Design a small or medium-sized real-life project applying the knowledge of theory subjects learned during the semester and other studies.

[#] The studio hours of Design courses will involve one to one counseling, review, and feedback sessions. Students are also expected to undertake substantial self-work beyond the prescribed studio hours.

Course ARC 607 (SA 6) *(Prepared by Prof. Sanjay Prakash)*

Energy Efficient Building Design – Theory and Technologies

4 credits **L-S-T per week: 4-0-0**

Pre-Requisites: Successful completion of ARC 604 (Climatology and Building Physics)

Broad Objectives and Outline

This course applies the fundamental learning of its earlier companion course (ARC604: Climatology and Building Physics) to familiarize the learners with the Theory and Technologies of Energy Efficient Building Design, especially in the Indian context. The aim is to provide knowledge and skills that will help students design buildings that will exhibit a low operating energy demand, especially for heating, cooling, and lighting.

Exercises during lecture sessions or beyond in this course are expected to create a familiarity with the technical concepts so that the students have well-rounded information of what is happening in practice as well as theory. It is encouraged, in the form of an assignment, to undertake secondary research on existing buildings in published literature and identify their energy efficient features — introduction to the relevant software.

Learning outcomes:

At the end of this course, the students will be able to:

- Explain the relevance of various climatic factors to undertake site analyses for developing climate-responsive site designs suitable for local conditions.
- Explain the influence of a built form, building envelope, fenestration, and shading devices to develop climate responsive building design.
- Describe the techniques and control devices ways of maximizing effective use of daylight while reducing the heat ingress.
- Identify the passive/hybrid design strategies and techniques for reducing the energy demands of the buildings, especially in the context of heating and cooling.

Contents:

1. Climate Responsive Site Design:
    a. Site Planning and Selection factors
    b. Site Analysis: Landform, Density of Existing Built Area, Climate analysis (wind, sun, rain), Vegetation, Existing Infrastructure, Urban Context, Site potential

2. Climate Responsive Building Design:
    a. Built Form: Layout, Orientation, Surface Area/Volume Ratio, Zoning of Internal Spaces, Buffer Spaces, Location of Openings
    b. Building surface and fabric: Insulation, color, window size location, and details
    c. Building Envelope and Fenestration Design: Transmission through Walls and Roof, Transmission through Windows, Window orientation and size, Shading Coefficient, Solar Heat Gain Factor, Visible Light Transmittance, Glazing Types
    d. Design of Shading Devices: fins, overhangs, pergolas, green roofs and walls, space frames, façade shading
    e. Calculation and estimates of the effectiveness of the same (shadow angles, sun path analysis)
    f. Shading by plants and soil
3. Daylighting:
    a. Concepts (health and other benefits)
    b. Design skies: Uniform Luminance Sky Distribution, CIE Standard Overcast Sky Distribution, Clear Blue Sky Distribution, Tropical Design Sky
    c. Direct, diffuse and reflected components
    d. Design Parameters: Glare, critical indoor and outdoor luminance, daylight factor and its calculation and distribution
    e. Techniques of incorporating daylight in buildings: galleries, porches, courtyards, atria, light-pipe and shafts, lateral pass-through components (windows, translucent wall, curtain wall), zenithal pass-through components (north lights, clerestories, translucent roofs, skylights, domes and lanterns), global pass-through components (membrane envelope), optical daylighting,
    f. Control devices: conventional divisions, optical division, prismatic division, awnings, curtains, overhangs, light shelves, sills, fins, jails, lovers and shutters, photochromatic and film controls
4. Passive and Low Energy Heating Systems:
    a. Principles and types: Direct Gain, Indirect Gain (Trombe walls, thermal storage walls), Isolated Gain (sunspaces, greenhouses, convective loops)
    b. Principles, advantages and disadvantages, control, and operating characteristics for each of the above systems
5. Passive and Low Energy Cooling Systems (based on shedding heat to air):
    a. Principles and types: Comfort ventilation, selective ventilation, chimney, and stack exhaust, climates applicable, air circulation

b. Design Factors Affecting Ventilation: Opening orientation, Size, Location, Internal Subdivision of Space, Cross Ventilation
c. Ventilation coupled with thermal storage mass

6. Passive and Low Energy Cooling Systems (based on shedding heat to evaporating water):
    a. Principles of evaporation, climatic applicability
    b. Direct evaporative systems: Passive/manually watered pads, mechanical evaporative coolers, and air washers, passive downdraft evaporative cooling including downdraft chimneys
    c. Indirect evaporative systems: Roof ponds, roof films, ground-based ponds, mechanical two-stage, and three-stage evaporative systems
    d. Plant-based evapotranspiration systems
7. Passive and Low Energy Cooling Systems (based on shedding heat to the ground):
    a. Principles of earth cooling, soil temperatures and its variation, climatic applicability
    b. Direct coupling of soil with buildings (berms, basements)
    c. Indirect coupling of soil with buildings (earth tunnels and pipes)
    d. Active coupling of soil with buildings (ground source heat pumps)
    e. Treatment of soil to change temperatures
8. Passive and Low Energy Cooling Systems (based on shedding heat to the sky):
    a. Principles of night-sky radiation, climatic applicability
    b. Skytherm and night radiant systems

Suggestive assignments and term papers:

Paper on Glare-free Daylight in Office Buildings

Paper on a detailed Case Study of an Energy Efficient Building, including primary observation and research.

Quiz / Tests on Low Energy Building Concepts covered during the course (no books allowed)

Assignment: Case studies of Existing Buildings in India in published Literature for identifying their Energy Efficient Features

The instructor may consider an Open Book End of Semester Examination

References:

- Ander, G. D., 2003. *Daylighting Performance and Design* (second edition), John Wiley & Sons Inc., New Jersey.

- Bureau of Indian Standards, 2005. *National Building Code of India, Part 8: Building Services, Section 1: Lighting and Ventilation*, New Delhi.
- Crosbie, M. J., 1998. *The Passive Solar Design and Construction Handbook*, John Wiley & Sons Inc., New York.
- Givoni, B., 1994. *Passive and Low Energy Cooling of Buildings*, John Wiley & Sons Inc., New York.
- Guzowski, M., 2000. *Daylighting for Sustainable design*, McGraw-Hill, New York.
- Majumdar, Mili (ed.), 2001. *Energy Efficient Buildings in India*, Tata Energy Research Institute and Ministry of Non-conventional Energy Sources, Government of India.
- Nayak, J. K., Prajapati, J. A., 2006. *Handbook on Energy Conscious Buildings*, Prepared under the interactive R&D Project No. 3/4(03)99-SEC between Indian Institute of Technology, Bombay, and Solar Energy Centre, Ministry of New and Renewable Energy, Government of India.
- Santamouris, M., 1996. *Passive Cooling of Buildings*, James & James (Science Publishers) Ltd., London.

Course ARC 608 (SA 7)

Building Services and Waste Management

4 Credits **L-S-T per week: 4-0-0**

Pre-Requisites: Graduation in Architecture

Broad Objectives and Outline

The broad aim of this course is to impart relevant information sufficient enough to students so that, as practitioners, they can work with a multidisciplinary team of consultants/experts and harness their design expertise and experience.

The first part of this course will introduce in detail all building services, safety, security and management systems, and the methodology to integrate these services and systems to enhance the sustainability of the developmental projects and buildings.

The second part deals with an important and critical area – Waste management. The focus is on treating waste as a resource. In this context, this course will look at solid and liquid wastes, their management, recycling, and reuse. Moreover, the segregation and classification of the waste through scientifically established waste management techniques would be encouraged as part of the design program. Efficacy of community participation in effective management, especially collection and segregation, waste reduction, use of recycled waste, etc. will be emphasized. In addition to this, the basic concept of W-to-E, i.e., waste to energy conversion and cradle to grave cycle would be considered.

Learning outcomes:

At the end of this course, the students will be able to:

- Demonstrate understanding of basic concepts, principles, and terminology related to building services and waste management sufficient enough to apply them in architectural design independently or while working with consultants.
- Describe the various components of MEP services with special reference to green and other innovative technologies.
- Explain basic concepts and techniques related to the design of sustainable human habitat with the aim of Net Triple Zero - energy, water, and waste.
- Describe the ‘4R’ approach and various technologies for scientifically managing waste as a resource with the involvement of different stakeholders.

Suggested Assignments

Field visit based documentation, analysis, and presentation of the existing system
Paper on available technologies using secondary sources

Contents:

PART A (2 Credits) - Building services:

1. Electrical Services
    - Introduction to basic concepts
    - Low voltage systems, Building management systems
    - Building Sensors for natural forces, fire, etc.
    - Introduction to smart grids
    - Equipment and their specifications
    - Low cost and green technologies
    - Innovative local design techniques (through live case studies)

2. HVAC systems and services
    - Introduction to basic concepts.
    - Building Automation and performance monitoring systems
    - Equipment and their specifications
    - Low cost and green technologies
    - Innovative local design techniques (through live case studies)
3. Fire Fighting systems
4. Sanitary and plumbing fittings
    - Historical perspectives and Introduction to basic concepts
    - Different valves and their working principle
    - Equipment and their specifications
    - Low cost and green technologies
    - Innovative local design techniques (through live case studies)

Part B (2 Credits) – Waste Management and Recycling

5. Introduction to Waste management
    - Wastes generated by Human Habitat – Solid, liquid and Gaseous
    - Types of Wastes- Municipal, Industrial, Agricultural, Toxic, Bio-Medical, Hazardous, Electronic, Radioactive, etc.
    - Overview of laws /rules governing waste management in India
    - Importance of Community participation in waste management
    - Impact on health and sanitation

6. Municipal Solid Waste management
    - 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 rainfall areas, waterfronts, etc
    - 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 a collection system for waste in different types of building structures
- Financial Models for Waste management
- Role of NGOs in effective waste management, sanitation, and health

7. Waste as a Resource
    - Recycling Industrial, agricultural and municipal waste
    - Recycling waste as an alternative material for buildings, landscape, and other products. Study of innovative practices for the use of recycled material
    - Specifications and construction methods for using recycled waste.
    - Demonstrative architecture and landscape using waste
    - Vermicomposting
    - Liquid waste from residential and commercial buildings recycling and reuse, Sewerage treatment plants
8. Energy from Waste
    - Biological and Thermal energy options
    - Energy from sanitary landfills
    - Refuse-derived fuel and other options

References:

- Ravindrarajah, R.S, Tam. T.C. Properties of concrete made with crushed concrete coarse aggregate, - Magazine of Concrete Research, Vol-37, March 1985.
- Arceivala. S.J., "Wastewater Treatment for pollution Control"- Tata-McGraw Hill, New Delhi, 1986.
- ERM.UK Municipal Solid Waste Management, Study for the MMA-Vol-1 Interim Report, August-1995.
- R.Ambalavanan and A.Roja "Feasibility Studies on Utilisation of Waste lime, Gypsum with Fly Ash - The Indian concrete Journal – Vol. – 70 Nov-1996.
- Municipal Solid Waste (Handling & Management) Rules 2016
- T V Ramachandra, Management of Municipal Solid Waste, TERI
- Rakesh Kumar and R N Singh, Municipal Water and Wastewater Treatment, TERI
- Sampa Chakrabarti, Treatment of Urban Solid Waste: engineering and integrated Management, TERI
- BioMedical Waste (Handling & Management) Rules
- Report of Ranganath Mishra Committee on recycling of PET.
- Waste Management World: ISWA Publication
- Indian Standard codes for electrical Layout
- Indian Standard codes for Fire Safety Norms
- NBC (selected sections)
- Plumber's manual by GmBH as per Uniform plumbing code of India
- Survey of vendor sites related to equipment specifications and current requirement.

Course Code: ARC 710 (SA 8) *(Prepared by Prof. Neeraj Gupta)*

Seminar Course

Credits: 2 Duration: About 30 hours of learning sessions

Pre-Requisites: Graduation in any Discipline with basic computer skills in word processing and desk top presentations

About the Course:

Students of architecture learn the art of presenting designs before the jury at the undergraduate level. However, there is a gap in their skills to analyze the information drawn after systematic literature research and present evidence-based arguments. This course aims to bridge this gap, develop critical thinking ability among the students, capacity to synthesize information from different sources, and communicate with academic rigor and integrity.

The course will allow them to explore the complex real-world issues with differing and multiple perspectives by readings articles, research studies, philosophical texts, and listening to experts on varied subjects.

This course will help students develop competence to present logical and evidence-based perspective after analyzing available literature and interaction with experts, and empirical studies. They will be able to develop their perspectives and deliver oral and visual presentations before a large heterogeneous group of people.

Learning Outcomes

After successful completion of the course, the student will be able to

- Apply effective strategy to undertake a literature survey through the university library and other resources.
- Identify, explore, and use reliable internet resources and e-database to gather information and perspectives related to a given topic.
- Evaluate multiple perspectives and synthesize ideas
- Work individually or in teams to present evidence-based arguments through essays/articles/papers and
- Make effective presentations and interact with diverse groups.

Approach to Learning

The approach planned is that of exploration and self-discovery by the students through prescribed readings, attend guest lectures, participate in seminars and webinars, listen, and view talks, read books and research papers, and experience artistic works and performances.

Contents:

Paper/Article/Book Review: The faculty guide/course coordinator(s) will, within one week of the commencement of the course, identify and provide a book or two research papers to summarize and to comment. Faculty will give due consideration to the student's area of interest and overall objectives of the course.

Seminars / Talks by External Experts: The faculty guide/course coordinator will advise the student to participate and then present a synoptic note of the talk. This will include major points made by the expert and the learning drawn by the student.

Presentation: Each student will make at least one well-researched presentation on any topic of interest selected with approval of the course coordinator(s)/HoD. The presentation will of about 30-35 minutes duration, followed by questions and discussions.

Formative and Summative Assessment

The course instructor or coordinator(s) and/or faculty member nominated by the HoD will assess the participation and submittals during the course, based on the evaluation criterion made available to the students well in advance. As an indicative list, the assessment will be made on the quality of research, thoroughness of reading, ability to link vide and varied topics, quality of analysis, and ability to craft and coherently present an argument.

A panel of faculty members/experts will base the summative assessment on the formal presentation by the student. If logistics permit, the panel will have at least one expert from outside the department/school/university.

Course ARC 609 (DSA 2)

Sustainable Architecture Design II

8 credits **L-S-T per week: 1-8-0 #**

Pre-Requisites: Successful completion of courses equal to minimum 14 credits during 1st semester of the M. Arch. Programme

The Design Studio Exercises in this semester will focus on Technology-Driven Buildings in the modern context. The focus of design exercise will be on services and creatively applying Architectural Design Principles to make buildings more effective and efficient in terms of energy, water, and waste.

There will be at least one minor exercise involving field studies and case studies. Thus, students will consolidate the learning of two core theory subjects taught during the semester - Energy Efficient Building Design – Theory and Technologies and Building Services and Waste Management. The studio exercise may be done individually or in small groups of 3-4 students as may be decided by the faculty member assigned to coordinate the studio.

One major design exercise will involve a Sustainable Architecture Design Project in a contemporary context that reflects a clear understanding of energy efficient building designs, building services, and waste management practices. The students must be able to demonstrate their understanding of the latest technologies and building practices related to sustainable architecture.

Note: To ensure complete harmony between theory subjects and design studio exercises, course instructors of the theory subjects may be available in the design studio to provide regular subject related inputs and periodically review the efforts of the students in their specific context.

Learning Outcomes

At the end of this course, the students will be able to:

- Work in a team to undertake studies of contemporary buildings that are worthy examples of renewable energy technologies, complex building services, sustainable waste management, innovative eco-sensitive design, and present the documentation before a group of experts.
- Design an Architecture project of substantive scale involving of building services and contemporary technologies and thus demonstrate an understanding of theory subjects learned during the previous semesters and other studies.

The studio hours of Design courses will involve one to one counseling, review, and feedback sessions. Students are also expected to undertake substantial self-work beyond the prescribed studio hours.

Course ARC 702 (DSA 3)

Summer Project

3 Credits L-S-T per week: 0-3[#]-0 (This is in addition to self-work during the summer break)
Pre-Requisites: Successful completion of courses equal to minimum 28 credits during 1st and 2nd semester of the M. Arch. Programme

The students will do active fieldwork and secondary studies during the summer break after the end of the second semester. In the third semester, students will spend about three hours per week spread over the semester or in two-three stretches in workshop mode depending on logistics and availability of internal and external experts.

Students are expected to take up an enabling summer project with prior approval of the that helps them gather knowledge and understanding to be applied to Master Design Thesis and Dissertation. These could be intensive documentation projects or Action Research projects or projects involving the community in sustainable architecture. The students may also undertake an internship with an organization working towards sustainable development and submit a work report. The student will choose a faculty guide from the University or outside (duly approved by the Dean of the School) and undertake work under their supervision and guidance. The students will be given face to face or e-mentoring support, including periodic review by their guides/university faculty.

Learning Outcomes

On successful completion of this course, the student will be able to:

- Document and present good practices of sustainable architecture through primary research and field studies or while working in an organization working towards sustainable development and architecture.
- Prepare a formal long report/document and present the documentation before a group of experts.

NOTE: The students will present a formal report and make presentations before a panel of experts in the third semester. The credits of this work will be counted in the third semester.

[#] The studio hours of Design/Project/Dissertation courses will involve one to one counseling, review, and feedback sessions. Students are also expected to undertake substantial self-work beyond the prescribed studio hours.

Course ARC 701 *(Prepared and Revised by Prof. Neeraj Gupta and Ar. Vivekanand Tiwari)*

Economic, Legal and Policy Framework for Sustainable Architecture

4 Credits **L-S-T per week: 4-0-0**

Pre-Requisites: Successful Completion of ARC 601 and ARC 605

Broad Objectives and Outline

With the world facing both human-made and natural disasters, it is important to understand the regulatory and policy framework for the development of human settlements and how economy and development is to be balanced with environmental concerns. Economics of Sustainable Architecture needs to be understood, taking the full life cycle perspective.

The course aims to present an overview of major issues related to governance, policy framework, and economics of development and how they support sustainable architecture. It will help students to understand the ground realities associated with the regulatory and economic environment of development implement sustainable design of the built environment.

Learning Outcomes:

On successful completion of this course, the student will be able to:

- Describe the economic approaches to sustainable development.
- Explain various phases of Project life cycle in the context of the social sector and infrastructure development projects.
- Explain the concept of various types of feasibility studies for development projects.
- Identify and describe the current government policies and schemes related to infrastructure, development of human habitat.
- Describe the broad objectives and applications of environment-related legislation that directly relate to architecture, urban development, and conservation of natural and built heritage.

Contents:

1. Economic approaches to measuring sustainable development, Measuring Wealth, Social capital
2. Project Life Cycle – Technical, Financial, Economic, Social and Institutional feasibility of developmental projects,
3. Concepts related to project financing, the rate of return, payback period social cost-benefit analysis, etc.
4. Overview of Central Government policies and schemes concerning housing and urban infrastructure finance, town planning, heritage conservation, etc. (e.g., SMART cities, HRIDAY, AMRUT)
5. Environmental Legislations (Introduction, understanding of objectives and applicability)
   a. Environment Protection Act of 1986
   b. Air (Prevention and Control of Pollution) Act
   c. Water (Prevention and Control of Pollution) Act
   d. The Real Estate (Regulation and Development) Act
   e. Indian Forest Act
   f. Wildlife Act
   g. Ancient Monuments and Archaeological Sites and Remains Act
   h. Hazardous Waste Management and Handling Rules / Biomedical Rules / Solid Waste Management Rules
   i. Environment Tribunal Act
   j. Building Construction Workers Act 1996

Suggestive assignments tests and term papers:

Papers are dealing with the economic aspects of sustainability, international treaties, etc.
Quiz / Test examining basic legal understanding (only bare acts allowed)
Project Work: A group of students (3-4) will choose/propose a developmental project and prepare a Project Report on a topic given by the instructor.

Mid Semester exam and End of semester exam may allow bare acts as per the paper setters' discretion.

References:

- Relevant Acts and Publications of Government / Autonomous bodies and other Agencies

Course ARC 703

Dissertation

8 Credits **L-S-T per week: Self Study Course with intermittent guidance**

Pre-Requisites: Successful Completion of 1st and 2nd Semester of M.Arch. Programme

Each Student will identify a topic and undertake primary research or an intensive documentation exercise as may be guided by the instructor and prepare a report running into around 100 pages of the main body (excluding supportive pages and annexure). Students will have to submit the soft copy and the hardbound report in duplicate to the department.

Formal presentation (face to face or video-conferencing in exceptional cases) and viva voce examination will be conducted by a Jury consisting of Internal and external experts as part of the summative assessment.

Learning Outcomes:

At the end of this course, the student will be able to

- Identify a topic of interest for research or documentation that individuals knowledge base related to sustainable architecture and development.
- Undertake systematic literature survey on a given topic.
- Develop a research methodology and carry out field studies and surveys
- Use technology to prepare dissertation reports and presentations
- Effectively present their ideas and research work before a panel of experts and in public forums.

The University policy related to plagiarism shall be applicable.

The studio hours of design/project and dissertation courses will involve one to one counseling, review, and feedback sessions. Students are also expected to undertake substantial self-work beyond the prescribed studio hours.

Course ARC 705 (DSA 6)

Sustainable Architecture Masters Design Thesis

20 Credits **L-S-T per week: Self Study Course with intermittent guidance ****

Pre-Requisites: Successful Completion of 1st to 3rd Semester of the Programme

Broad Objectives and Outline

The master's design thesis will be a real-life design project that shall be carried out under the supervision of an internal guide and a practicing Architect as a professional external guide.

The design thesis will be presented in the form of a report of about 100 pages presenting the theoretical and technological framework of design and Architectural presentation drawings supported by other material as may be required to explain the project.

The student will make a formal presentation of about 45 to 60 minutes before a formal jury constituting of internal and external experts who shall after viva-voce evaluate the designs and presentation and award marks/grades.

Learning Outcomes:

At the end of this course, the student will be able to

- Work in a team to undertake studies related to neighborhood planning and large area Development and present the documentation before a group of experts.
- Demonstrate understanding of campus planning, sustainable settlement planning, landscape design, and the statutory framework related to waste management, environmental protection, and sustainability through a large scale project.

The studio hours of Design courses will involve one to one counseling, review, and feedback sessions. Students are also expected to undertake substantial self-work beyond the prescribed studio hours.

** This is largely a self-study project course with formal classes limited to two one week review and feedback studios as may be decided by the HoD.

Elective Course: ARC 711 (*Prepared by Dr. Sanjeev Vidyarthi)*

Research Methods in Architecture

2 Credits **L-S-T per week : 2-0-0** (Approximately 32 interactive learning sessions**)**

Pre-Requisites: Successful Completion of 1st Semester of the Programme

Learning Outcomes:

After successful completion of this course, the student will be able to:

- Identify a potential research topic related to sustainability in the built environment and present an overview of the research design process and frame a research question.
- Describe the conceptual and analytical frameworks for the literature review
- Explain various methods commonly used for research in Architecture and identify pertinent methods for their research
- Develop a strategy for field work
- Present a brief research proposal before a panel of experts.

Contents:

Unit: 1

a. Overview defining and operationalizing sustainability in the built environment, identifying and measuring over time change in the built environment, the significance of case study research in studying built environments

b. Overview research design process, elements, and principles of research design framing a meaningful and feasible research question

c. Individual exercise – articulating potential research topics, feasible cases, and identifying an appropriate research question

Unit: 2

a. Importance of literature review, drawing relevant insights and highlighting contextual arguments from existing scholarship

b. Overview conceptual and analytical frameworks

c. Individual exercise –identifying relevant literature, distinguishing and composing conceptual and analytical frameworks in line with the research question

Unit: 3

a. Overview importance of hypothesis in research design, conceiving and framing a meaningful hypothesis

b. Overview research methods commonly used research methods for studying built environments

c. Individual exercise – conceiving relevant hypothesis and identifying pertinent research methods in continuation of previous tutorials.

Unit: 4

a. Overview composing the research proposal, bringing the research design elements together

b. Designing a research strategy for fieldwork, paying attention to local contexts and regional variations

c. Individual exercise –composing the research proposal by building upon previous tutorials followed by designing an appropriate research strategy

Unit: 5

a. Overview presenting a research proposal, obtaining and incorporating peer feedback

b. The final presentation of individual work in oral and written formats.

References:

Course ARC 712 (SAE 2)

Water Management

2 credits **L-S-T per week: 2-0-0**

Pre-Requisites: Graduation in any Discipline

Broad Objectives and Outline:

With the growth of population and the development of economy and society, water has become a rare resource in the whole world. To optimize the allocation of water is an important content of sustainable development. This course thus brings to focus concepts related to resource-oriented water conservancy that takes the optimized allocation of resources and the balance of environmental ecology as the system target.

Concerning sustainable architecture, urban design and settlement planning it is prudent to the unified planning of atmospheric water, groundwater, underground water, and sewage and, on this basis, to scientifically develop, use, control, allocate, save and protect water resources.

Learning Outcomes:

After successful completion of this course, the student should be able to:

- Describe the need and importance of Management of Water for Architecture students
- Describe various systems for treatment, supply, and drainage of water in the context of sustainable development of human habitat.
- Describe traditional methods of water harvesting and conservation used by communities in different climatic zones and geographic terrain
- Describe various facets of Architecture related to water systems in India with special emphasis on Rajasthan.
- Explain the approach to the planning of settlements and large campuses based on watershed
- Identify various technological options and products for the efficient use of water in buildings

Contents:

1. Management of water cycle as a single system and its relevance for sustainable architecture.
2. Water Management for human habitats: Social and economic imperatives, environmental considerations, regulatory mechanisms, pricing.
3. Water-related Traditional community wisdom, in different climatic zones and geographical terrain.
4. Traditional Architecture Related to water systems in India with special reference to Rajasthan- Stepped Wells, Baoris, Tankas, etc
5. Planning of settlements and large campuses based on principles of sustainable watershed development – water as a priority resource
6. Rainwater harvesting techniques – Basic Concepts, Piping techniques, and Pit design of groundwater recharge wells, etc.
7. Technological Options and Products for effective water management, recycling, reuse, conservation and treatment

References:

- John Briscoe, R.P.S. Malik Editors, 2007, Handbook of Water Resources in India: Development, Management, and Strategies: OUP
- Ramaswamy R. Iyer, Editor, 2009, Water And The Laws In India: Sage Publications India Pvt. Ltd.,
- Jain, Sharad K., Agarwal, Pushpendra K., Singh, Vijay P. 2007, Hydrology and Water Resources of India, Water Science and Technology Library, Vol. 57
- Guy Honore, for, 2002, Principles and Practices of Integrated Watershed Management in India, Indo-German Bilateral Project
- Rao, K. Nageswara (Ed.), 2006, Water Resources Management: Realities and Challenges, Eastern Book Corpn.
- NATHANSON, JERRY A, 2002, Basic Environmental Technology: Water Supply, Waste Management, and Pollution Control; Prentice Hall
- Dr. B C Punmia, Ashok Kr Jain, Arun Kr Jain; Water Supply Engineering, Laxmi,
- Cunliffe, D. (ed) (2011). **Water safety in buildings**. Geneva, Switzerland, World Health Organization. ISBN-13 9789241548106.
- P.K. Singh Rainwater Harvesting, Macmillan Publishers India
- R.N. Athavale, 2003, Water Harvesting and Sustainable Supply in India, Rawat Publications

Web References :

- NIUA Publications http://www.niua.org/publications.asp
- UNEP Publications http://www.unep.or.jp/ietc/ws/index.asp
- http://pollution.researchtoday.net/books-pollution.htm
- https://washresources.wordpress.com/category/topics/water-supply-topics/water-distribution/
- http://www.cseindia.org/taxonomy/term/20167/menu

Elective Course ARC 713 (*Prepared by prof. Neeraj Gupta & Ar. Karan Barpete)*

Sustainable Urban Transportation: Basics of Transport Planning and Design at Neighborhood Level

3 Credits **L-S-T per week : 2-2-0** (Approximately 30 Interactive Lecture Sessions and in addition requisite Studio/Field Work)

Pre-Requisites: Successful Completion of 1st Semester of the M. Arch. Programme

Broad Objectives and Outline

This course is an introductory course on transportation design for neighborhood-level projects. The main emphasis of this course is to educate the students on the importance of transportation in Architecture and help them learn basic transportation planning techniques which they can use in their designs. It also introduces urban mass transit systems like metro rail and BRTS and the design requirements that come with these projects.

Learning Outcomes:

At the end of this course, the students will be able to:

- Explain the fundamental principles of transportation in urban areas and within campus designs.
- Demonstrate a basic understanding of movement geometry in campus designs and specialized designs like metro stations, bus stations, and multi-modal interchanges.
- Use standards of transportation as described in IRC codes in their architectural designs.
- Design parking spaces for large scale buildings, campuses, and urban areas.
- Analyze traffic and movement data to create time-space prisms that can help architectural designs become more accessible and efficient.
- Understand and implement policies of Transit Oriented Development.

Course Contents:

1) Fundamentals of Transportation
   a) Overview of components of transport planning
   b) Understanding circulation and movement in a large area development project like Academic campus, district centers, residential neighborhoods, etc.
   c) Accessibility and Walkability - Calculating accessibility and walkability at a neighborhood scale using network analysis. Types of accessibility index – Reach metric, Gravity, Closeness metric, Straightness, and Betweenness metric.
   d) Optimizing transportation costs and energy use by designing ‘walkable’ campuses. (a Case study of campus planning; examples of the design of walkways, foot-over bridges, subways, pedestrian crossing, etc.).
2) Streetscape and Community Planning
   a) Using the IRC codes for movement design within communities. Using IRC codes in conjunction with the streetscape. (a Case study of any large area development).
   b) Design for overcrowding and congestion. Speed calming techniques in streetscape and urban design. Use of Urban design to control movement.
   c) Figure out Bicycling requirements in a campus plan and inclusion of bicycle sharing within campuses – (Case study of campuses designed to promote bicycling).

3) Parking
   a) The social cost of roadside parking.
   b) Techniques for maximizing the number of vehicles parked in a high-density settlement. Community design to avoid roadside parking. Estimation of parking requirements for residential, commercial, and public projects.
4) Introduction to Public Transportation Systems
   a) Understanding various forms of Mass Transit systems like Metro, Railway, Trams and Buses and Design requirements for the surface, elevated and underground stations.
5) Transit Oriented Development (TOD)
   a) Introduction to National Urban Transport Policy
   b) Regulatory framework and building regulations for TOD
   c) Impact of mass transit systems on housing choices, housing price, and land value.
   d) Planning of commercial and retail establishments near airports, metro, rail, and bus stations according to TOD principles.
6) Research Potential in Transportation Planning and Design
   a) Showcasing contemporary research in this field.
   b) Future areas for researchers – A set of research questions need to be identified, that need answers

Formative and Summative Assessment

A. Continuous Internal Assessment of 40% marks consisting of
   Written Test (20%)
   Field Study / Assignment / Term Paper (20%)
   Quiz (announced and unannounced)
B. End of Course Assessment of 60% marks consisting of:
   Project[1] / Paper Presentation with Viva Voce and/or Written Exam or a combination of both as may be decided by the course instructor

Suggestive assignments tests and term papers

Accessibility and walkability analysis of their present or previous semester design project. This will include parking estimates and identification of suitable location and design of parking based on the analysis.

References and Reading Material

- *City form lab, MIT. (2016, January 20). Urban network analysis toolbox. Retrieved from Urban network analysis: http://cityform.mit.edu/projects/urban-network-analysis.html*
- *Global Designing Cities Initiative. (2016). Global Street Design Guide. Island Press.*
- *Moughtin, C., (2003). Urban Design: Street and Square. Architectural Press.*
- *Robert Horonjeff, F. C. (n.d.). Planning and Design of Airports. McGraw Hill.*
- *Shoup, D. C., (2017). The High Cost of Free Parking. Routledge Traylor & Francis Group.*
- *Transport and Sustainability. (2014). Parking Issues and Policies (Vol. 5). (C. M. Stephen Ison, Ed.) Emerald Group Publishing Limited.*
- *Urban Land Institute II National Parking Association. (n.d.). The Dimensions of Parking.*

[1] All students will undertake a project as advised by the course instructor. For example, they may undertake accessibility and walkability analysis of a given project or their own design studio project of current or previous semester. This analysis will among other issues my include parking estimates and suitable location of parking based on the walkability analysis.

Course ARC 714 (SAE 4) *(Prepared by Ar. Sanjay Prakash)*

Renewable Energy Technologies

2 Credits **L-S-T per week: 2-0-0**

Broad Objectives and Outline

This course will give a general understanding of the various renewable energy production technologies, especially with an emphasis on building integration in urban areas (mainly solar thermal and photovoltaic).

Learners shall be able to understand the principles and applicability, and size and integrate solar thermal and photovoltaic systems in buildings. Also, they will be acquainted with other renewable sources with an emphasis on India.

It is encouraged, in the form of an assignment, to undertake secondary research on existing buildings in published literature and identify their renewable energy sources.

Objectives:

After successful completion of this course, the student will be able to:

- Demonstrate understanding of basic concepts, principles, and terminology of different Renewable Energy production.
- Apply and size and integrate solar thermal and photovoltaic systems in buildings.
- Appraise various government schemes and incentives and economics of integration of renewable energy sources in built forms.

Contents:

1. Fundamentals:
    a. Force, energy, and power
    b. The first and second law of thermodynamics
    c. Types of renewable energy sources
    d. Firm and infirm sources
2. Solar thermal energy:
    a. Solar thermal flux and the greenhouse effect
    b. Types of collectors and components: flat plate, evacuated tube, concentrating, tracking, storage, plumbing, maintenance, controls and instrumentation
    c. Sizing, mounting, and angling of collectors, building integration
    d. Closed and open loop systems, active and passive systems
    e. Eco-model of ownership
    f. Maintenance and life-cycle cost, annual output estimation
    g. Solar Ponds
    h. Solar chimneys
    i. Applications: for heat, power, and combined
3. Solar photovoltaic energy:
    a. History of the technology, operating principles, the structure of silicon cells
    b. Types of PV cells and components: crystalline, thin films, storage batteries, storage in water head, grid-interactive systems, stand-alone systems
    c. Sizing, mounting, and angling of collectors, building integration
    d. Operating characteristics

    e. Maintenance and life-cycle cost, annual output estimation
    f. Solar PV farms
4. Wind energy:
    a. Wind flow, power density
    b. Types of turbines
    c. An estimate of wind turbine rating, annual output
    d. Integration with buildings
    e. Hybridization with solar photovoltaic
5. Biomass energy:
    a. Sources: woody and agriculture crops
    b. Energy from various types of wastes
    c. Biomass conversion: methanation, gasification, charcoal, incineration
6. Other renewable energy sources and carriers:
    a. Geothermal
    b. Tides
    c. Waves
    d. Biotechnological and algal storage
    e. Hydrogen and fuel cells
7. Economics of Renewable Energy Technologies
8. Contemporary Government schemes/ programs to give incentives for environmental up-gradation and energy efficiency.

Suggestive assignments tests and term papers:

- Undertake secondary research on existing buildings in published literature and identify their renewable energy sources
- Paper on sizing solar hot water systems
- Paper on sizing a solar photovoltaic system with batteries
- Quiz / Test on Renewable Energy Concepts during the course delivery (no books allowed)
- Assignment: Case studies of Existing Buildings in India in published Literature for identifying their Renewable Energy Features
- Examination at the end of Semester may be an assignment followed by a presentation and viva voce or a routine exam or an open book exam as per the course instructor's decision.

References:

- Boyle, G., 2004. *Renewable Energy: Power for a Sustainable Future* (second edition), Oxford University Press, Oxford.
- Gevorkian, P., 2008. *Solar Power in Building Design: the Engineer's Complete Design Resource*, McGraw-Hill Companies Inc., USA.
- Hodge, B. K., 2010. *Alternative Energy Systems and Applications*, John Wiley & Sons Inc., USA.
- Kishore, V. V.N., 2008. *Renewable Energy Engineering and Technology*, TERI Press, New Delhi.

- Solanki, C. S., 2009. *Renewable Energy Technologies: A Practical Guide for Beginners*, PHI Learning Pvt. Ltd., New Delhi.
- TERI, 2004. *Sustainable Building Design Manual Volume 2*, prepared under a European Union co-funded ASIA-URBS project under the leadership of Institut Catala d'Energia (Spain), The Energy & Resources Institute, India

Course ARC 715 (*Revised by Ar. Ritu B Rai – Revised in January 2019)*

Sustainable Neighborhood Planning and Urban Design

3 Credits **L-S-T per week: 3-0-0**

Broad Objectives and Outline:

Given the rapid and haphazard growth of towns and cities and associated problems of the environment, it is important to understand the macro and micro issues that connect the environment and human habitat. This course looks at the relationship between the built environment with the overall environment. Our ancient traditional wisdom has been able to create a built environment that was responsive to climatic and other local conditions and also aesthetically pleasing. Most of the human habitat that one comes across in villages are built on sustainable design principles. Thus this course looks at strategies that have been in use since historical times to create sustainable neighborhoods. At the same time, it looks at how modern technology can be used to achieve goals of sustainable development.

Learning Objectives:

After successful completion of this course, the student should be able to:

- Apply vernacular as well as modern urban design strategies that can mitigate the negative impacts of urban climate.
- Appreciate the role of efficient resource (water, waste, materials, energy) management in the development of a sustainable neighborhood.
- Demonstrate an understanding of the concepts of Urban renewal, different government schemes of slum Upgradation.
- Understand and implement URDPFI guidelines
- Integrate renewable energy resources and smart grid at the neighborhood scale.

Contents:

1. Climate-sensitive design in different climatic Zones of India
2. Traditional design strategies of human habitats in India and other parts of the world with a special focus on resource management and built forms in response to harsh climatic conditions.
3. Concepts and Principles related to “Eco-Village.”
4. Urban pollutants and their impact on air, water, land, and microclimate;
5. Impact of built density, building footprint, the urban form including height and geometry, the orientation of streets, etc. on microclimate, especially light, ventilation, and temperature.
6. Improving environmental quality, energy efficiency, efficient resource management (soil, water, waste, and materials) through appropriate site selection, effective neighborhood planning and Urban design strategies; transport planning, land-use zoning strategies, landscape planning, etc.
7. Concepts related to urban renewal, namely inner city regeneration, revitalization of the "townships" and informal settlement/slum upgrading.
8. Integrating renewable energy at the neighborhood scale, smart grids, the concept of solar cities,

Suggestive assignments / tests / projects / papers:

- Papers may be research-based or documentation of vernacular, traditional and modern architecture in different climatic zones with special focus on energy efficiency.
- Project Work: A group of students (3-4) will study a neighborhood or human settlement or existing campus and undertake its detailed study in the context of sustainability. The course instructor should so design the topics that the collective output of the class can yield meaningful documentation on the specific topic/area/ building typology/ geographic region.
- One mid-semester exam may be replaced by formal presentation/viva voce by external experts on the project work

References:

- CIRIA, The SUDS Manual, CIRIA C 697
- Emmanuel., R., 2005. An urban approach to climate-sensitive design: strategies for the tropics, Span Press, Taylor, and Francis Group.
- UDPFI Guidelines, Part I and Part II, 1996, Ministry of Urban Development and Poverty Alleviation, Government of India.

Course Code: ARC 716

Technical and Scientific Communication for Architects

Credits: 3 **L-S-T per week: 3-0-0**

Broad Objectives and Outline

Architect's prime language is drawings and sketches. During the undergraduate studies in Architecture, there is a very limited focus on writing skills to produce effective technical and scientific documents. With the technological changes in the recent past, design drawings and sketches are no longer sufficient for bidding for Architectural projects, justifying the design decisions, or even for the execution of the project. These projects now require a scientific justification for design decisions and documentation of design. This course is designed to help you fill the knowledge gap and develop your writing skills.

Learning Outcomes:

After successful completion of this course, the student should be able to:

- Demonstrate an understanding of the basic principles and methods of scientific and technical writings.
- Write research papers, technical reports, dissertations, and other documents commonly used in scientific and technical fields and organizations.
- Demonstrate formal presentations and oral communication skills, to effectively communicate the scientific and technical information in seminars, conferences, and other public forums

Contents:

Unit 1: Basics of Communication

- Process of Communication
- Communication as a Social Behavior – Linguistic and Non-Linguistic Component.
- Distinctive features of Business, Technical and Scientific Communication
- Developing Project Documents - Converting design drawings to design documents.
- Using Appropriate Language
- Using search engines and other resources for research
- Importance of scientific indices and peer-reviewed journals
- Common Errors in the English Language - Tenses, Preposition, Subject-Verb Agreement, Determiners.
- Choosing appropriate Words - Abstract and Concrete words, Technical words and Acronyms, Gender Neutral Words, Words that stereotype by race, age, etc.
- Passive and Active Voice
- Construction of Sentences and Paragraphs

Unit 2: Writing Skills

- Forms of Written Communication (Letters, emails, Business, and Technical Reports, Press-Release, research papers, etc.)
- Process of Writing
- Structure of Technical and Scientific Reports, Synopsis, Dissertation, and Research Papers.
- Writing proposals for funding support
- Legal Documentation – MoUs and Contracts

- Review of Literature
- Referencing – Overview of different styles
- Use of software for citation and bibliography; Developing your publication projects using free tools like Mendeley citation and library manager.
- Importance of Academic Integrity, Using plagiarism detecting software for clean writing.

Unit 3: Making Effective Presentations

- Formatting reports and other documents for visual appeal – Structure, Fonts, Diagrams, pictures, tables, etc.
- Overview of Public Speaking – speaking in small groups, making formal presentations before experts, public seminars and paper presentations in conferences
- Identifying the right platform for presentation: Difference between conference proceedings and journal publications and their impacts.
- Process of preparing formal presentations – Strategy, Developing Content, Preparing presentations.
- Making Effective Presentations - Using Visual Aids and Technology effectively, Audience analysis, Body Language and Voice Modulation, Handling Questions.

References:

- Anderson, P .V. (2007). Technical communication: a reader-centered approach.
- Aruna, K. (2010). Professional communication.
- Becker, H. S., & Richards, P. (2007). Writing for social scientists: how to start and finish your thesis, book, or article.
- Berger, A. A. (2008). Academic writer's toolkit, the: a user's manual.
- Chaturvedi, P.D., and Chaturvedi Mukesh (2017). The Art and Science of Business Communication,
- Lesikar, R.V. and Flately, Marie E. (2005) Basic Business Communication; Skills for Empowering Internet Generation.
- Osborn S., Osborn M., and Osborn R. (2008) Public Speaking Guidebook.
- Raymond Murphy, Essential English Grammar- (A self-study reference and practice book for elementary students of English.)
- Tyagi, Kavita, and Misra, Padma, (2011) Basic Technical Communication

Course ARC 718 (SAE 14)

Project Management for Sustainable Architecture (Revised by Prof Neeraj Gupta and Ar. Abjijit Rastogi)

3 Credits **L-S-T per week: 2-0-1** (About 42 learning sessions)

Broad Objectives and Outline:

This course intends to impart the knowledge of the basics of the science of project management in the field of sustainable architecture. The basic objective is to impart skills so that students can learn to execute projects while dealing with all organizational, technical, financial, human resource, and sustainability issues.

Learning outcomes:

After completion of this course, participants will be able to:

- Explain the fundamental principles of management and describe the various schools of management thoughts from historical to current times.
- Demonstrate a basic understanding of Project Management, Project Planning and Project Financing
- Develop a basic cash flow requirement for a simple building project.
- Describe various phases of the Project Life Cycle.
- Prepare bar charts and showing a list of activities in various phases of project management in the context of the implementation of sustainable architecture projects.

Contents:

1. Fundamentals of Management – Concepts and Principles, Relevance and Application of Classical and Contemporary management thoughts for Construction Projects, Managerial Roles and Skills
2. Introduction to Project Management: Basic understanding of:
    a. Project Life Cycle for developmental projects and Infrastructure projects
    b. Types of Project Feasibility
    c. The Process Management Framework
    d. Project Organizations
3. Project Planning
    a. Scheduling, Time management
4. Project Financing
    a. Life Cycle Costs
    b. Cost-Benefit Analysis
    c. Overview of NPV, Time Value for Money, etc.
    d. Cash Flows
    e. Overview of project delivery models (Engineering Procurement and Construction, Public Private Partnership)
5. Project Management Phases:
    a. Pre – Construction Activities
        i. Surveys, studies, and documentation as required for sustainable architecture

ii. Selection and Appointment of Consultants
    a. Preparing and responding to EoIs, RFPs, (samples to be studied)
    b. Design Briefs for Sustainable Architecture. (samples to be studied)
iii. Overview of scope management.

b. During – Construction Activities
    i. Managing Contracts with Consultants, contractors, vendors
    ii. Design Coordination
    iii. Monitoring Projects from Architect's and Client's Perspective
    iv. Project Scheduling
    v. Basics of Project Risks

c. Post Construction Phase Activities
    i. Taking / Handing over the site for occupation
    ii. Managing warranties and Guarantees
    iii. Checklists for Snags and Defects
    iv. Introduction to facility management

Suggested Exercises / Papers / Projects /Assignments:

Assignment: Preparing project activity schedules, Cash flow, Preparing EOIs, Design Briefs, Paper on Cost-benefit analysis of a sustainable building Quiz / Class tests on safety, health and environment issues in project management, Teamwork and other HR issues.

References:

- Paul C. Dinsmore - PMP; Jeannette The AMA Handbook of Project AMACOM; 2nd edition,
- Turner, Simister, 2000, Gower Handbook of Project Management, Gower Publishing Ltd,
- Dr. Vasant Desai, 2009, Project Management, Himalaya Publishing House,
- K.K Chitkara, 1998 (reprinted-2009), Construction Project Management: Planning, Scheduling, and Control McGraw Hill,
- K.K Chitkara, 2001, Construction Project Management Techniques And Practice, McGraw Hill, 2001

Course ARC 719 (SAE 15) *(Prepared by Ar. Mahesh Paliwal)*

Sustainable Landscape Architecture

3 Credits **L-S-T: 3-0-0**

Broad Objectives and Outline:

This course will cover the theory of landscape architecture, plants and design, landscape management/ economics, heritage, and cultural landscapes. The main emphasis of the total outcome of the course shall be site planning and landscape engineering.

Learning outcomes:

On successful completion of this course, the students will be able to:

- Present an overview of landscape design covering important historical cases in Indian and International context.
- Describe the Hierarchy of open spaces and the safety and security aspects in landscape design
- List eco-sensitive landscape building materials, and plant varieties
- Demonstrate an understanding of various aspects related to exclusive landscapes.
- Undertake ecological analysis of sites with regarding physiography, microclimatic conditions, soil, and local vegetation

Contents:

1. Introduction to Landscape Architecture: Historical Landscape and Contemporary Landscape in Indian and. International context.
2. Hierarchy of open space
   - City level
   - Neighborhood-level
   - Playfields: Indoor and Outdoor
3. Security and Safety Aspects in Landscape Architecture
4. Eco-sensitive Landscape Building Materials
5. Plants
   - Textures, colors, spread, heights, etc.
   - Understanding of Indigenous species
   - Qualitative aspects of plants
   - Thematic aspects of the use of plants in space
6. Exclusive Landscape
   - Interior and atrium Landscape
   - Roof Landscape and Green Walls
   - Creating Microclimate
   - Placemaking
7. Ecological Analysis of Site with the following parameters
   - Physiography (Slope and Relief)
   - Soil
   - Geology
   - Vegetation
   - Visual
   - Microclimate

Suggestive assignments tests and term papers:

Paper on plant ecology and stratification
Paper on landscape management on regional scale/biodiversity
Assignment: Case studies of sustainable landscape designs/ biodiversity parts / regional parks/woodlands in different climatic zones.

References:

- BIS codes, Landscape codes, Landscape Architecture by Simonds John Ormsbee,
- Site Analysis: Informing Context-Sensitive and Sustainable Site Planning and Design by James A. LaGro Jr.; Need for resource-conscious landscaping by Prarthana Rao and Sabita Kaushal
- A handbook of landscapes by CPWD India
- Time Savers-Landscape Architecture
- NBC
- IGBC Green Landscape Rating System
- Updates scholarly papers to understand different concepts

Course Code: ARC 720

Green Building Certification

Credits: 2 **L-S-T: 2-0-0** (May be in a workshop mode with about 32 hours of learning sessions)
Pre-Requisites: Successful Completion of 1st Semester of the M.Arch. or 2nd Semester of M.Sc. Environmental Science Programme and competency to read drawings

Broad Objectives and Outline:

We built our 'green' buildings thousands of years back. Traditional and vernacular architecture of India has always been designed to respond to local climatic conditions and use local building materials. The world holds in awe historic architecture of forts, palaces, and hawelis where passive design techniques achieved thermal comfort. However, most of the contemporary architecture seems to rely on importing designs, materials, and technologies. The result is an array of glass-clad look-alike buildings in all cities. With increasing awareness about sustainability, more and more, organizations are looking for energy efficient buildings. Investors and corporations are now demanding green, certified buildings. The users are demanding healthier, and higher quality buildings and are willing to pay a higher price for such buildings.

Building regulations of many states encourage 'green buildings' and incentives like additional FAR is being offered to promote green certified buildings. In short, there is a demand for professionals who understand the green building rating systems and certifications and have basic knowledge of rating tools available in India.

The course will allow you to understand how the building regulations, codes, and green rating programs work. This course will help you develop competence to rate buildings using at least one of the rating systems used in India. You may be able to understand the financial considerations of green buildings.

Learning outcomes:

After successful completion of the course, the student should be able to:

- Describe what are 'green buildings' the financial considerations of green buildings and the concept of Life Cycle Costing
- Describe various green certification systems used in different parts of the world.
- Describe the IGBC Green Building Rating Systems
- Work individually or in teams to evaluate a building based on GRIHA Rating systems.

Approach to Learning

The approach planned is that of a series of interactive lecture sessions by experts and exploration and self-study by the students through prescribed readings like GRIHA manual, webinars, etc.

Contents

1. Green Buildings – Definition, Financial Aspects, Life Cycle Costing
2. Introduction to Green Rating Systems used in different parts of the world:
    a. BREEAM
    b. CASBEE
    c. Green Star
    d. HK-BEAM
    e. LEED Rating system
3. Indian Green Building Council Green Building Rating Systems
    a. Introduction to different rating systems, for example for New Buildings, Existing Buildings, Homes, Campus, Townships, etc.

b. Overview of Certification Procedure

4. GRIHA – The National Rating System
    a. Comprehensive Understanding of GRIHA Rating system,
    b. Underlying criterion and
    c. Rating procedure
    d. Case Studies Of GRIHA Registered/Rated Buildings

Formative and Summative Assessment

The faculty will make an assessment based on the written exams, quizzes, and submittals during the course. A panel of faculty members/experts will base the summative assessment on the formal presentation by the student on a given topic. Also, an end of semester exam may be scheduled as decided by the course instructor. If the logistics permit, the panel will have at least one expert from outside the department/school/university.

References:

- GRIHA Manual, National Building Code, Energy Conservation Building Code
- Overview of green building rating tools.
- (More to be added by the Course Instructor)

Course Code: ARC 721

Basic Teaching Skills for Higher Education[2] *(Prepared by Prof. Neeraj Gupta)*

Credits:3 **L-S-T 3-0-0 (**About 42 hours of Interactive Lecture/Activity Sessions and some off class work)

Pre-Requisites: Successful completion of 1st semester of Masters Programme in any discipline

Broad Objectives and Outline:

This course, specially designed for persons aspiring to become teachers after their Masters and Ph.D. program, will equip them with the knowledge and skills necessary for effective teaching. Various teaching methods like lectures, student seminars, group discussions, coaching, mentoring, and project work, will be covered. The course will help learners to understand nuances teaching-learning process, classroom management, and handling challenging situations. The course will also cover contemporary issues in higher education like choice based credit framework, design of learning events, evaluation and feedback, and use of various synchronous and asynchronous learning formats. Participants will also get the opportunity to practice teaching methods, make presentations, and receive feedback.

Learning Outcomes:

On successful completion of this course, learners should be able to:

- Explore the attributes of effective teaching,
- Describe the adult teaching-learning process,
- Identify and apply suitable teaching methods in the classroom, studio, labs, and field situations and professional settings.
- Develop lesson plans for courses
- Use case studies, activities and exercises in the classroom
- Use visual aids effectively for lectures and seminars
- Facilitate and support e-learning
- Explore ways of handling challenging behavior in classrooms
- Demonstrate enhanced competency in communicating with students.

Participants

The course is open to all students of Masters and Ph.D.program and teachers who are desirous of enhancing their teaching competencies.

Contents:

1. **Overview of Adult Learning Theories (approx. 3 hours)**
   a. Pedagogy vs. Andragogy
   b. Kolb's Learning Cycle
   c. Learning Styles
2. **Curriculum Design and Development (approx. 6 hours)**
   a. Choice Based Credit System
   b. Developing Lesson Plans
   c. Developing case studies, activities, and exercises

[2] Open Elective Course Designed by Prof. Neeraj Gupta. Can also be offered as Summer/Winter Course

3. **Teaching Methods (approx. 6 hours)**
   a. Traditional teaching strategies
   c. Activity-based teaching strategies
4. **Direct Teaching Skills (approx. 12 hours)**
   a. Using visual aids effectively – Black/White Boards, Flip Charts, Models, Computers and LCD projectors
   b. Class Room Management
      i. Organizing the physical environment
      ii. Managing the lesson, activities, and interaction
      iii. Managing Behaviour, handling challenging situations
      iv. Managing Self
      v. Providing developmental and motivational feedback
   c. Counseling and Mentoring
   d. Guiding Design and Research-Based Projects
   e. Formative and Summative Assessment, Using Evaluation Rubrics
   f. Supporting 'Slow Learners'
5. **Designing and Delivering Effective Lectures (approx. 4 hours)**
   a. Structuring contents
   b. Delivery methods
   c. Handling questions-**Learning (approx. 4 hours)**
   d. Introduction to MOOCs
   e. Role of Teacher in E-Learning
6. **Managerial Skills for teachers (approx. 6 hours)**
   a. Role of a University Teacher – (Academic, Administrative, Supportive)
   b. Effective Communication
   c. Leadership skills
   d. Organizing Seminars, Conferences and other Events,
   e. Managing Records

Learning Methods

It is an intensive course that will rely on interactive lecture sessions, powerpoint presentations, group discussions, role-plays, mock teaching, and facilitation session sessions with video recording and feedback.

Elective Course ARC 722

Simulation and Modelling for Building Energy Performance

2 Credits (32 Interactive Lecture / Activity Sessions)[3] Prerequisite: SA04 and SA06

Learning Outcomes:

After completion of this course, the students will able to:

- Describe various energy Efficiency compliance approaches for the building as per relevant Code/ standards
- Identify various input parameters for software used for building energy performance calculations.
- Select and use appropriate software for whole building performance simulation and daylight simulation for showing compliance of parameters given by ECBC /other relevant codes in the Indian context.
- Identify and recommend various Energy Efficiency Measures (EEMs) for achieving the energy-efficient design of buildings.

Contents

1. Fundamentals of Simulation
    a. General overview and Specific about Energy Simulation
    b. Types of Simulation – Whole Building / Component
    c. Case study – 1 – Overview (Walk thru one project)
    d. Geometry
    e. Weather file
    f. Construction
    g. Schedule
    h. HVAC / Lighting
    i. Basic data collection to start the simulation
2. Shading and Massing Analysis of Architectural Forms
3. Daylighting – 1 – Fenestration Size, Location, Material, Performance
4. Artificial Lighting
5. Conditioned Building – Basic Systems
6. Natural Ventilation
7. Energy Simulation for ECBC

Suggested Assignments:

- *Working on the development of Templates*
- *Daylighting; Artificial Lighting*
- *HVAC – Natural Ventilation*
- Analyzing Small Conditioned office for its energy performance and ECBC compliance
- Parametric Analysis

[3] Students may be required to work beyond contact hours. The course may be run in a workshop mode. This may be one-week workshop or the duration may be split into two-three workshops of shorter duration.

Course Code: ARC 723

Academic Research Writing

Credits: 2 **L-S-T: 2-0-0**

This will be a modular course of about 32 hours duration to be delivered as series of seminars and workshop by in-house and external experts.

Pre-requisite: Graduation in any Discipline with working knowledge of word processing and desk top presentations.

Broad Objectives and Outline:

It is an Ability Enhancement Compulsory Course and an important supportive part of Dissertation Course offered in Programme. This course aims to develop skills in professional and research writing and presentations. (The students are free to opt for a similar course through MOOC)

Learning Outcomes:

On successful completion of the course, and with some additional self-practice the students will be able to:

- Describe distinguishing features and structure of research writing and process of writing
- Write research papers with proper formatting
- Write professional emails
- Make effective presentations in conferences

Course Contents:

- Distinguishing Features of Research Writing
- Structure of Research Papers and Dissertation
- Process of Writing – Planning – Writing – Revising - Presenting
- Using Technology Effectively:
    - Online research
    - Referencing: Introduction to different styles, Use of software for creating bibliography and referencing
    - Grammar Check
    - Page-Making and Graphics
- Making Presentations in Seminars and Conferences
    - Using desk top presentation tools to create presentations
    - Managing Time
- Writing Professional Mails and Letters.

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- Carmine Gallo, (2009) The Presentation Secrets of Steve Jobs: How to Be Insanely Great in Front of Any Audience, McGraw-Hill Education
- Lesikar, R.V. and Flately, Marie E. (2005) Basic Business Communication; Skills for Empowering Internet Generation