Course Structure
And
Detailed Syllabus

For

M. Arch. (Sustainable Architecture)

2022-23

DEPARTMENT OF ARCHITECTURE AND PLANNING

NATIONAL INSTITUTE OF TECHNOLOGY PATNA

Annexure-I

Course Structure of M. Arch.(Sustainable Architecture) 16.03.2022

(Semester 1)								
Sl. No.	**Group**	**Sem**	**Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1	Core 1	1	AR450101	Design Studio-I	2	0	4	4
2	Core 2	1	AR450102	Sustainable Built Environment	4	0	0	4
3	EL	1	AR430XXX	Elective -I	3	0	0	3
4	EL	1	AR430XXX	Elective-II	3	0	0	3
5	EL	1	AR430XXX	Elective-III	3	0	0	3
6	Lab	1	EAA00103	EAA-Sports/Innovative Project/NCC	0	0	2	1
7	Lab	1	AR450104	Technical Report Writing Tools	0	0	2	1
				Total Semester Credits	**15**	**0**	**08**	**19**
(Semester 2)								
Sl. No.	**Group**	**Sem**	**Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1	Core 1	2	AR450201	Design Studio-II	2	0	4	4
2	Core 2	2	AR450202	Urban Design	4	0	0	4
3	EL	2	AR430XXX	Elective-IV	3	0	0	3
4	EL	2	AR430XXX	Elective-V	3	0	0	3
5	EL	2	AR430XXX	Elective-VI	3	0	0	3
6	Lab	2	EAA00203	EAA-Swachha Bharat Mission (SBM)	0	0	2	1
7	Lab	2	AR450204	Seminar	0	0	4	2
8	Lab	2	AR450205	Comprehensive Viva	0	0	2	1
				Total Semester Credits	**15**	**0**	**10**	**21**
(Semester 3)								
Sl. No.	**Group**	**Sem**	**Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1	Lab	3	AR450301	Project	0	0	20	10
				Total Semester Credits	**0**	**0**	**20**	**10**
(Semester 4)								
Sl. No.	**Group**	**Sem**	**Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1	Lab	4	AR450401	Project	0	0	24	**12**
				Total Semester Credits	**0**	**0**	**24**	**12**
				Total (Sem I, II, III & IV)	**30**	**0**	**62**	**62**
Elective-I								
Sl. No.	**Group**	**Sem**	**Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1	EL	1	AR450111	Contemporary Architectural theories and trends	3	0	0	3
2	EL	1	AR450112	Architectural Critique	3	0	0	3
3	EL	1	AR450113	Sustainable heritage Conservation and Management	3	0	0	3
				Elective-II				
4	EL	1	AR450121	Sustainable Building Materials and Technology	3	0	0	3
5	EL	1	AR450122	Intelligent buildings & futuristic architecture	3	0	0	3
6	EL	1	AR430123	Sustainable and green buildings	3	0	0	3
				Elective-III				
7	EL	1	AR450131	Building modeling & simulation	3	0	0	3
8	EL	1	AR450132	Digital architecture	3	0	0	3
9	EL	1	AR450133	Artificial Intelligence in building	3	0	0	3
				Elective-IV				
10	EL	2	AR450211	Assessment of built environment	3	0	0	3

11	EL	2	AR450212	Energy Audit &Environmental Impact Assessment	3	0	0	3
12	EL	2	AR450213	Energy Efficient Building Design – Theories and Technologies	3	0	0	3
				Elective-V				
13	EL	2	AR450221	Project Management & Finance				
14	EL	2	AR450222	Waste Management	3	0	0	3
15	EL	2	AR450223	Construction Project Management	3	0	0	3
				Elective-VI				
16	EL	2	AR450231	Advance Building Services	3	0	0	3
17	EL	2	AR450232	Public space infrastructure and design	3	0	0	3
18	EL	2	AR450233	Mega Structure	3	0	0	3

Detailed Syllabus of M.Arch. (Sustainable Architecture)

Semester 1

1. Core 1

AR450101 ***Design Studio-I***	**L-T-P** **2-0-4** **4 credits**

Aim: To develop architectural design for large scale projects with a focus on environmental sustainability

Course content:

1. Understanding of sustainability and built environment
2. Sustainable strategies and conceptuality
3. Sustainable projects- Case studies
4. Green Retrofitting

Suggested Studio Exercises:

Analytical studies of sustainable practices in traditional and contemporary contexts of:

1. Low rise buildings,
2. Medium rise buildings
3. High rise buildings
4. Campuses, neighbourhoods

Expected outcome: Develop analytical sense for the principles and technologies for sustainable architectural design and developments.

Reference Books:

1. *Merlino, Rogers Kathryn Building Reuse "Sustainability, Preservation, and the Value of Design", University of Washington Press 2018*
2. *Ching, D. Francis Shapiro, M. Ian, "Green Building Illustrated Wiley", 1st edition 2014*
3. *Weintraub Alan and Hess, Alan Frank Lloyd Wright, "Natural Design, Organic Architecture: Lessons for Building Green Rizzoli", Illustrated edition 2012*
4. *Szokolay, V Steven, "Introduction to Architectural Science: The Basis of Sustainable Design", Architectural Press; 2nd edition, 2008*
5. *Sassi, Paola, "Strategies for Sustainable Architecture", Taylor & Francis, 2006*
6. *Buchanan, Peter Ten Shades of Green, "Architecture and the Natural World Architectural League of NY",1st edition 2006*
7. *Bennetts, Helen and Radford, "Antony Radford and Williamson, Terry Understanding Sustainable Architecture", Taylor & Francis, 2002*

2. Core 2

AR450102 ***Sustainable Built Environment***	**L-T-P** **4-0-0** **4 credits**

Aim: To impart knowledge about sustainability and the built environment and to examine sustainability in the built environment through various processes of building design.

Unit – 1

Definition, issues and impacts of built environment - physical impacts on water, air, land, noise, natural environment; social impacts (stress); environmental degradation. Sustainability and its various dimensions (economic, social and ecological).

Unit – 2

History of sustainability; Sustainable development; Global warming and climate change; Sustainable architecture and built environment; Culture and sustainability. Traditional Sustainable Practices: Elements and principles of sustainability in vernacular architecture, case studies.

Unit - 3

Interrelationship of site and buildings; Urban physics; thermal, visual and acoustical comfort; sustainable landscape. Assessment of existing resources; Solar architecture; Recycling/reuse strategies; Optimization techniques; Advances in HVAC, lighting, electrical and plumbing, active systems; Sustainable transport, walkability and last mile connectivity.

Unit – 4

Study of rating systems; Strategies to earn credits; Life Cycle Assessment- concept, terminologies, methodologies, tools and processes; Carbon footprint.

Unit – 5

Net Zero Energy and Energy Positive Buildings: Definition, concept, strategies.

Expected outcome: The course allows students to respond more quickly to the urgent need for a greater understanding of sustainability issues in the built environment.

Reference Books:

1. *Banham, Reyner, "The Architecture of the Well-tempered Environment", Architectural Press, 1969*
2. *Clarke, JA, "Energy Simulation in Building Design" ,Routledge,1985*
3. *Hensen, Jan & R. Lamberts, "Introduction to Building Performance Simulation", Spon Press, 2011*

Semester 2

1. **Core 1**

AR450201 ***Design Studio-II***	**L-T-P** **2-0-4** **4 credits**

Aim:
Introduction to the complexities of the Urban and exploration of the methods of documentation, analysis and interventions and to develop insight in urban design aspects.

Course content:

1. Analytical studies of traditional and contemporary public spaces.
2. Street design
3. Riverfront development
4. Urban renewal
5. Sustainable urbanism and urban retrofitting in different contexts; Design Solutions for the Contexts.

Expected outcome: Mapping multiple layers of urban complexities followed by design demonstration through the use of drawings/models/sketches.

Reference Books:

1. *Farrelly,L., "Drawing for Urban Design (Portfolio Skills: Architecture)", Laurence King Publishing,2011.*
2. *Haas, T., "Sustainable Urbanism and Beyond: Rethinking Cities for the Future", Rizzoli,2012*
3. *Massengale, J. and Dover, D., " Street Design: The Secret to Great Cities and Towns", Wiley, 2013.*
4. *Dixon, T., Eames, M. and Lennon, S.; Urban Retrofitting for Sustainability: mapping the Transition to 2050", Routledge, 2014.*
5. *Hirsh, A.B.; City Choreographer: Lawrence Halpin in Urban Renewal America; University of Minnesota Press, 2014.*

2. Core 2

AR450202 ***Urban Design***	**L-T-P** **4-0-0** **4 credits**

Aim: The aim of this course is to develop concepts of urban design at various urban scales to enable engaging in an effective design process that entails holistic approach and equip them with appropriate relevant urban design techniques and tools.

Unit - 1

Introduction of Urban Design and Cities, Early examples of Urban Design in classical and pre-industrial cities – Heritage and the roots of our modern concepts in urban design.
Basic functions, principles and techniques of Urban Design. Modern Techniques, Methods and Emerging Approaches to Urban Design; Behavioural Issues in Urban Design; Principles of Urban Spatial Organization.

Unit – 2

Urban Analysis through Surveys in Urban Areas; Scale in Urban design - Understanding Scale and Issues of Urban Design Interventions and Strategies in Cities, urban mass, perceiving and mapping a city. Urban activity and circulation. Examples at regional, metropolitan, Urban and project level; Urban Spaces - Hierarchy and Nature, Sense of Enclosure, Isolation and Continuity, Skin and Perception; Urban Massing in Built Form; effect of light, sense of enclosure, detail design aspects;

Unit - 3

Imageability and Elements of Urban Design according to Kevin Lynch; The Social, Perceptual, Temporal and Morphological Aspects of Urban Design; Urban design survey technique and its application; Modern techniques and emerging approaches to urban design; Techniques of Urban Design with emphasis on public policies, conservation and economic considerations, Road forms, serial, grid-iron, Hierarchy of access routes - Pedestrian areas and malls and Urban elements.

Unit - 4

Urban Design at Micro Level: Campus Planning, City Centres, Transportation Corridors, and Residential Neighbourhoods, Designing urban waterfront.

Unit - 5

Legal aspects with respect to Land Acquisition Act and Town Planning acts. Development Control Guidelines, Zoning - Restrictive, Indicative, Performance and Incentive Zoning. Urban Arts Commission. Planning and Design parameters for New sustainable Urban spaces. Case Studies of Urban Design and Urban renewal Projects: Best Practices and Analysis of Urban Design Projects in India.

Expected outcome: To prepare the students to develop a holistic view of the city as a basis for designing the city components in sustainable approach.

Reference Books:

1. *Kevin Lynch, "The Image of the City", MIT Press, 1960*
2. *Paul D Spreiregen, "Urban design: the architecture of towns and cities", American Institute of Architects,1965.*
3. *Edmund Bacon, "Design of Cities", Harmony (Aesthetics) Publisher New York,1967*
4. *Cullen, G., "Townscape", London Architectural Press,1968*
5. *Christopher W. Alexander, Sara Ishikawa, Murray Silverstein, Max Jacobson, Ingrid Fiksdahl-King, Shlomo Angel, "A Pattern Language: Towns, Buildings, Construction", Oxford University Press,1977.*
6. *Arthur Gallion, Simon Eisner, "The Urban Pattern: City Planning and Design", Van Nostrand Reinhold, 1986.*
7. *Spiro Kostof, "The City Shaped", Bulfinch,1991.*
8. *Sunil Khilnani, "The Idea of India; Farrar", Straus and Giroux, 1999*
9. *Cliff Moughtin, Rafael Cuesta, Christine Sarris, Paola Signoretta, "Urban Design: Method and Techniques", Architectural Press, 1999.*
10. *Mathew Carmona, Steve Teisdell, "Public Places Urban Spaces: Dimensions of Urban Design", Architectural Press, London, 2003.*
11. *Jonathan Barnett, "Redesigning Cities: Principles, Practice, Implementation", APA Planners Press, 2003*
12. *Donald Watson, Alan J. Plattus, Robert G. Shibley; "Time-saver standards for urban design", McGrawHill, 2003*
13. *Stephen Marshall, "Streets and Patterns", Routledge, 2004*
14. *Michael Larice · Elizabeth Macdonald, "The Urban Design Reader", Routledge, New York, 2006*
15. *Alex Krieger, William S. Saunders, "Urban Design", University of Minnesota Press, 2008*
16. *Fransesc Zamora, "Source of Contemporary Urban Design", Harper Collins Publisher, 2012*

Semester 3

1. Lab

AR450301 ***Project***	**L-T-P** **0-0-20** **10 credits**

Aim: To make the students understand the process of carrying out research and to effectively programme the thesis for the fourth semester.

Topics related to various aspects of Architecture and allied subject would be chosen in consultation with faculty members. Emphasis must be on critical understanding, logical reasoning and structured writing.

Course content:

1. Introduction, definition, objectives of research, types of research, research process
2. Collection of primary data, data tabulation, and analysis, to draw inferences.
3. Topics related to various aspects of Architecture and allied subject would be chosen in consultation with faculty members. Emphasis must be on critical understanding, logical reasoning and structured writing.
4. Research design and method formulation, selection of tools for research, data collection and management, case studies, site survey and mapping data analysis for the selected topic.
5. Writing and communication skills for written and oral presentations; professional communications. Comprehensive study and research on chosen topic, presentation of findings in a series of seminars by individual students.

Documentation and formal presentation as a Dissertation at the end of the semester. The outcome paper would be of 3000 to 4000 words with Standard referencing conventions and technical writing norms.

Outcomes: Students finishing this course will be able to comprehend the data collected which may be useful for further thesis; Analyze the focus of research carried out further in the thesis.

Reference Books:

1. *Anderson, J. and Poole, M, "Thesis and assignment writing. Brisbane", John Wiley, 1998*
2. *Kothari. C.R, "Research Methodology; New Delhi", New age International Publisher, 2004*
3. *Murray, R., "Writing for academic journals", Berkshire: Maidenhead Open University Press,2005*
4. *Borden, I. and Ray, K. R., "The dissertation: an architecture student's handbook. 2nd Ed"; Oxford: Architectural Press, 2006.*
5. *Raiyani, J.R, "Research Methodology-Theory and techniques", New century publications, 2012.*

Semester 4

AR450401 ***Project***	**L-T-P** **0-0-24** **12 credits**

Aim: To provide an opportunity to each student to undertake an original topic for thesis/project based on the research work done and as approved in the 3rd semester.

Course Content

Each student shall prepare a thesis on the topic approved by synthesizing and applying knowledge and skills acquired through the learning of various theories and practical during the course. This shall be done in several stages, when their works shall be monitored and evaluated internally by a panel as given below:

1. Thesis proposal
2. Development of suitable methodology/Framework
3. Literature survey and review
4. The study area
5. Data collection, analysis, synthesis and case studies
6. Findings/results
7. Discussions, inferences, conclusions and recommendation/proposals
8. Bibliography

Evaluation at various stages shall be done through seminars.

The final output shall be in form of a draft report, which will be submitted in the form of a detailed report including drawings/visuals for external jury members, in the format specified by the institute. The thesis shall also be presented in an oral form to a jury by each student.

Expected outcome: Students finishing this course will be able to process the data and use the analysis part of data for outcomes and recommendation for the thesis topic.

Reference Books:

1. *Tayie Sami, "Research Methods and Writing Research Proposals", Pathway to higher Education, 2005*
2. *Murray, Rowena, " How to Write a Thesis; Open University Press", McGraw Hill Education, UK, 2011*
3. *Elizabeth A. Wentz, "How to Design, Write, and Present a Successful Dissertation Proposal", Sage Publications, 2013.*
4. *John Biggam, "Succeeding with Your Master's Dissertation: A Step-by-Step Handbook", Open University Press, McGraw Hill Education, 2015.*

Detailed syllabus of elective subjects offered in M. Arch. (Sustainable Architecture) in Semester 1

Elective-I (Semester 1)

AR450111 ***Contemporary Architecture Theories and Trends***	**L-T-P** **3-0-0** **3 credits**

Aim: To impart knowledge of contemporary theories and trends in architecture

Unit - 1

Contemporary world architecture, related theories and trends; Modernism and international style, Bauhaus school, De Stijl movement; Architectural works and philosophies of master architects

Unit - 2

Late Modernism: Concepts, relationship to modernism, influences, debates on ornamentation, sculptural forms, slick tech architecture, late modern space, architectural works and philosophies of late modern architects.

Unit – 3

Post Modernism: Concepts, relationship to modernism, influences, double coding style, critical regionalism, neo vernacular, ad hoc urbanism, architectural works and philosophies of post-modern architects.

Unit – 4

Advance Theories in Contemporary Architecture: Deconstructivism, biomimicry, blobitecture, parametric design, Mobius Strip, trends in high rise structures, architectural works, emerging building typologies.

Unit – 5

Indian Modernism: Post Independence modernist architecture; Architectural works and philosophies of modern Indian architects.

Expected outcome: To make students understand the history of architecture through its use of contemporary ideologies. Topics cover a wide range of trends in architecture based on colour, drawing, ornament, structure, construction, material, inhabitation, gender, class, race, nationalism, etc.

Reference Books:

1. *Frampton, K., "Modern Architecture-A Critical History", Thames and Hudson, 2002*
2. *Gossel, P. and Leuthauser, G., " Architecture in the 20th Century; Vol. 1 & 2", Taschen, 2005*
3. *Jencks, C., Kropf, K.," Theories and Manifestoes of Contemporary Architecture", Second edition, Wiley Academy, 2005*
4. *Gossel, P.," The A-Z of Modern Architecture", Taschen GmbH, 2007*
5. *Mehrotra, R.," Architecture in India: Since 1990", Pictor Publishing Pvt. Ltd, 2011*
6. *Smith, K.," Introducing Architectural Theory", Routledge, 2012*

Elective-I (Semester 1

AR450112 *Architectural Critique*	**L-T-P** **3-0-0** **3 credits**

Aim: To provide students with a more comprehensive understanding of the theory and criticism of architecture. The course surveys historical and theoretical contents in significant, selective issues of architecture. The course seeks to develop critical reading, analysing and writing of modern and contemporary issues in architecture.

Unit – 1

Definition of architectural theory & Critiques; Concept of architectural criticisms of the built environment; Criteria of architectural criticism of the built environment; Architectural Critiques of built environment projects for case studies.

Unit - 2

Early modernize the formation of modern movement (1894-1914)

Unit - 3

Late Modern Movement to Modernize (1920 -1945)

Unit - 4

Huge Modernize in the past was yours to critiques of Modernize (Till 1959-69)

Unit - 5

Prospects of a Past Modern Theory (1969-79) to present architectural theory & critiques.

Expected outcome: students will understand to the importance of critique and analysis in architecture, important principles and tactics, and how to apply those techniques to selected architectural projects.

Reference Books:

1. *Alan Colquhoun., "Essays in Architectural Criticism: Modern Architecture and Historical Change", MIT Press,1982*
2. *Joan Ockman, "Architecture, Criticism, Ideology", Princeton Architectural Press, 1985.*
3. *Alan Colquhoun. "Collected Essays in Architectural Criticism", Black Dog Publishing, 2009.*
4. *Andrea Simitch, Val Warke, "The Language of Architecture: 26 Principles Every Architect Should Know", Rockport Publishers, 2014.*

Elective-I (Semester 1)

AR450113 ***Sustainable Heritage Conservation and Management***	**L-T-P** **3-0-0** **3 credits**

Aim: To develop technical expertise in conservation of historic buildings, structures and sites through sound strategies that ensure sustainable conservation.

Unit – 1

Process of identification of heritage assets and methodology of listing. Computer application in Heritage Recording and Monitoring Information Systems (MIS). Photography, Arial Photography and Photogrammetry. Preparation of Maintenance programs for historic buildings; Planning, Policy formulation, and standards for maintenance.

Unit – 2

Specification of Conservation and Maintenance works: material specifications, performance specifications, measurement and valuation of conservation works.

Unit – 3

Sociology and anthropology as fields of enquiry to include cultural role of built form and social constructs of space: Understand heritage as integral to society and culture.

a. Assessment of local histories, values and implications on cultural studies; heritage as a continuum through time.
b. Local and indigenous understanding of heritage to include the monumental and the vernacular-built form, related crafts skills and craftsperson, practices, rituals, festivals etc.
c. Stakeholders in heritage conservation: Identification of and role of stakeholders.

Unit - 4

Research methods on community studies: Community participatory resource assessment techniques; Cognitive mapping; Cultural mapping etc; Social access, territoriality, exclusion and inclusion of communities; Syncretism and contestations in heritage sites.

Unit - 5

Community perception and public participation in heritage conservation. Participatory processes and frameworks; advocacy planning for conservation; concepts of social, cultural, environmental and economic sustainability.

Expected outcome: Develop an understanding on relationships between heritage conservation and sustainable development and how conservation of cultural heritage can contribute to resilience, social cohesion, and to other sustainable development aspects.

Reference Books:

1. *Rene van Grieken, KoenJanssens, "Cultural Heritage Conservation and Environmental Impact Assessment by Non-Destructive Testing and Micro-Analysis", CRC Press, 2004*
2. *Sudha P Rao, "Evolution of Heritage Conservation in India", Vrinda Publications, 2020*
3. *Gill Chitty, "Heritage, Conservation and Communities: Engagement, participation and capacity building", Routledge, 2016.*
4. *Kapila D. Silva, AmitaSinha, "Cultural Landscapes of South Asia: Studies in Heritage Conservation and Management", Taylor & Francis, 2016.*
5. *ICCROM , "Conservation of Architectural Heritage and Historic Structures", ICCROM, 1999*

Elective-II (Semester 1)

AR450121 ***Sustainable Building Material and Technology***	**L-T-P** **3-0-0** **3 credits**

Aim: To get a comprehensive overview of materials used for sustainable buildings and to understand the effects of technology on materials their sustainable use.

Unit – 1

Sustainable building materials, qualities, use, examples - Natural building materials, locally available and locally manufactured materials, bio materials - Salvaged and recycled materials - Nontoxic materials: low VOC paints, coating and adhesives.

Unit - 2

Concept of embodied energy and carbon footprint: Idea of embodied energy - Development of the concept, factors to be considered, calculation techniques for embodied energy.

Unit – 3

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

Unit – 4

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

Expected outcome: Expose students to the concepts of sustainability in the context of building and conventional sustainable building materials.

Reference Books:

1. *Mcharg, I. L., "Design with Nature", John Wiley and Sons Inc, 1992*
2. *TERI "Sustainable Building - Design Manual Pt 1 & 2", The Energy and Resources Institute, TERI, 2004.*
3. *Jagadish. K.S. "Alternative Building Materials and Technologies", New age International Pvt Ltd Publishers, 2008*
4. *Ross Spiegel.G, Green Building Materials A Guide to Product Selection and Specification, 3rd Edition by, John Wiley & Sons, 2010*

Elective-II (Semester 1)

AR450122 ***Intelligent Buildings and Futuristic Architecture***	**L-T-P** **3-0-0** **3 credits**

Aim: To understand and integrate the concept of intelligent buildings by integration and optimization of building structure, services systems, information technology, management and value-added services.

Unit - 1

Significance of Intelligent buildings. Artificial intelligence, knowledge-based systems, artificial neural networks, genetic algorithms, fuzzy controls. Composition of intelligent buildings – physical building intelligence, building management and operation. Economical and technical aspects of intelligent building technologies.

Unit - 2

Facilities management for intelligent buildings. Building automation systems - approaches, application – lighting, security, fire detection, office automation, vertical transportation, surveillance. Technologies – field devices, digital controllers, system controllers, man-machine interface, Sensors. Automation control strategies.

Unit - 3

Future concepts envisioned by Antonio Saint Elia, Frank Lloyd Wright, Corbusier. Future trends being evolved by Marcos Novak, Neil Denari, Greg Lynn, Toyo Ito and others.

Unit - 4

Evolution of contemporary architectural concepts such as biomimicry, adaptive reuse, low-cost development and urban regeneration. Futuristic building materials, building tectonics and systems of the future.

Unit - 5

"Zero energy" and "Energy +" buildings with emphasis on an integrated approach. Economic impacts of future urbanism.

Expected outcome: Develop an understanding about integrate structure, services, system and management of intelligent building so as to create a futuristic architectural space and environment which is comfortable, productive and friendly for the occupants or users of the building.

Reference Books:

1. *Andrew Harrison & Eric Loe, "Intelligent Buildings in South East Asia", Spon Press, 1997*
2. *Albert Ting-Pat so &WaiLokchan, "Intelligent Building Systems (The international series on Asian studies in computer and information science)", Springer, 1997*
3. *Michael Nigginton & Jude Harris, "Intelligent skins" Architectural Press, Oxford, 2002.*
4. *Derek Clements – Croom (ed), "Intelligent Buildings: Design, Maintenance and Operation, Thomas Telford, London, 2004*
5. *Jodidio, P., "Building a New Millennium", Vol.1 Taschen, 2003*
6. *Jodidio, P., "Architecture Now", Vol. 2, Taschen, 2004*
7. *Bell, J., "21st Century House", Laurence King Publishing, 2006*

Elective-II (Semester 1)

AR450123 ***Sustainable and green buildings***	**L-T-P** **3-0-0** **3 credits**

Aim: To get a comprehensive knowledge about the various aspects of sustainable and green building design in the context of global warming and climate change.

Unit – 1

A historical perspective. General premises and strategies for sustainable and green design, objectives and basis. Bio-mimicry as a design tool based on ecosystem analogy.

Unit – 2

Sustainable architecture and Green Building: Definition, Green building evaluation systems; LEED Certification; Green Globe Certification; Case studies which look at the environmental approach;

Unit – 3

Renewable Energy; Controlling the water cycle, Impact of materials on environment; Optimizing construction; Site management; Environmental management of buildings.

Unit – 4

Passive Design and Material Choice – Traditional Building Materials – Importance of envelope material in internal temperature control – Specification for walls and roofs in different climate – Material and Humidity Control.

Unit – 5

The form of the house, the building as an analogy. Building concepts: energy loss, insulation, passive solar gain, active solar gain, health benefits, sustainable materials. Small scale wind and hydro power systems. Case study of eco house.

Expected outcome: Expose the students to the concepts of sustainability in the context of energy consumption and self-sustainable building with minimum waste generation.

Reference Books:

1. *Ken Yeang, "Eco Design- A manual for Ecological design", Wiley Academy, 2006*
2. *Sue Roaf et all: Ecohouse, "A design guide", Elsevier Architectural Press, 2007*
3. *Thomas E Glavinich, "Green Building Construction", Wiley, 2008*
4. *Brenda and Robert Vale, "Green Architecture, Design for a Sustainable Future", Thames and Hudson, 1996*

Elective-III (Semester 1)

AR450131 ***Building Modeling and Simulation***	**L-T-P** **3-0-0** **3 credits**

Aim: To provide fundamental knowledge of building sciences for the development of high-performance buildings utilizing energy modelling and simulation technology as an energy performance analysis.

Unit – 1

Introduction to energy efficient buildings; Building physics; Latent, specific heat gains in the building; Psychometric analysis; Weather analysis;

Unit – 2

Energy use in buildings; Energy Supply in Buildings: Heating, Ventilating, and Air Conditioning (HVAC) Systems; Heating and cooling loads;

Unit – 3

Daylighting and artificial lighting analysis;

Unit – 4

Energy Performance Analysis: Energy Codes, Guidelines, and Standards;

Unit – 5

Constructing energy simulation models: Thermal modelling, Models for ventilation, Steady state and dynamic heat flow analysis; Evaluating models: Measurements, Comparisons and verifications

Expected outcome: Enable students to develop building information modelling and simulation for understanding and enhancing the energy performance.

Reference Books:

1. *Banham, Reyner, "The Architecture of the Well-tempered Environment", Architectural Press, 1969*
2. *Michael B Kaplan, "Guidelines for Energy Simulation of Commercial Buildings", Bonneville Power Administration, 1992*
3. *Clarke, JA, " Energy Simulation in Building Design", Routledge, 1985*
4. *Heschong, Lisa, "Thermal Delight in Architecture" , MIT Press,1979*

AR450132 ***Digital Architecture***	**L-T-P** **3-0-0** **3 credits**

Aim: To cover a varied spectrum of domains of investigation within the premise of digital architecture.

Unit – 1

The 'c' language and control flow structures, arrays, string functions and pointers, functions and structures, file handling and file i/o, data structures, stacks, queues and binary trees
Object Attributes/Parameters, Data Types, Data Structures, and Designing with Algorithm, Parametric Design and its usefulness, its relationship to the Design process, Graphical Algorithms, Use in Exploring Ideas, Storage and Access to Data; Manipulating Lists and Data Trees, Best practices for integrating Graphical Algorithm editor

Unit – 2

Introduction, optimisation method, fundamental concepts of optimality, design optimisation practice, modelling, Process of systematically evaluating the performance and effectiveness of one or more aspects of buildings with issues such as Thermal comfort, visual comfort, aesthetics, cost-effectiveness, functionality, productivity, safety and security, and sustainability. Pre-Design evaluation of learning environments and Post-occupancy evaluation of learning environments. Evaluation tools in practice such as VASARI (Green Suite), IES, BIM, IAS etc. and using other convention techniques such as Questionnaire Survey, Physical Measurements of Thermal Environment, Lighting Measurements and other Environmental Measures through case studies for analysis.

Unit – 3

Advance Ecotect and Energy Modelling, Integration of ECOTECT with BIM, RAPID ENERGY MODELLING - Modelling and performance, Simulation of existing buildings – residential-institutional-design of a new residential building with ECOTECT.

Unit – 4

Emerging Computer Technologies How emerging computer technologies influence architecture and all building industries with an emphasis on digital design processes and digital manufacture possibilities.

Unit – 5

High end-3D modelling and animation. Focus on MAYA - The state of art modelling software. Hypergraph Modeling: Nurb Modeling/ Polygon Modeling / Organic Modeling Animation: Working with Key frames and Breakdowns/ Deformers/ Character setup/Rendering: Lighting/ Shading/ Texture Advanced Effects and MEL Scripting Language.

Expected outcome: Students will understand the various digital software tools design processes, architectural visualization and building automation.

Reference Books:

1. *Bjarne Stroustrup , "The C++ programming language (3rd edition)", Pearson, 2002*
2. *Panos Y. Papalambros and Douglass J. Wilde, "Principles of Optimal Design – Modeling andComputation", Cambridge University Press, 2000*
3. *Mitsuo Gen and Runwei Cheng, "Genetic Algorithms and Engineering Optimization", Wiley, 2000.*
4. *Baird, G., Gray, J., Isaacs, N., Kernohan, D., and McIndoe,G. Wellington, "Building Evaluation Technique", McGraw-Hill, Inc., 1996.*
5. *Perry Hrovas, et al., "MAYA Complete 2", BPB Publications, 2000.*

Elective-III (Semester 1)

AR450133 ***Artificial Intelligence in Building***	**L-T-P** **3-0-0** **3 credits**

Aim: To bridge the gap between architecture and technology based on AI and provide general basic training adapted to train in trans-disciplinary design.

Unit – 1

Theoretical foundations of Artificial Intelligence processes for Architecture and Design
Designing and implementing end-to-end Artificial Intelligence (AI) solutions. Apply infrastructure and Architecture concepts using AI frameworks, machine learning and algorithms to develop an AI solution that solves a real-world challenge.

Unit – 2

Artificial Intelligence (AI) systems – To enable robotic devices to better interact with their physical environment, as well as enhance the autonomy and efficiency of automation systems.

Unit – 3

Integration of AI technologies with traditional automation systems such as heating, ventilation and air conditioning (HVAC) and progressive assembly systems to create intelligent automation solutions.
The potential benefits of new technology evaluate the feasibility of implementation and apply new technologies.

Unit – 4

To design and implement the latest Artificial Intelligence tools to solve these challenges.
The concepts of complex systems, ecology, network analysis, and AI.
Explore innovative applications of AI and its interfaces through computational creativity and generative design.

Unit – 5

Deep Learning (DL), Machine Learning (ML), Multi-Agent System Design (MASD), person-centred Environmental Intelligence (AAL), Evolutionary Computing (EC), Shape Grammar (SG) and Linear and Logistic Regression (LR, in the data analysis process of Data Mining, in the theoretical discourse, and the language consolidation process.

Expected outcome: Artificial intelligence related aspects were become familiar with students and enable them to incorporate technology based facilities in the building.

Reference Books:

1. *Parag Kulkarni, Prachi Joshi, "Artificial Intelligence - Building Intelligent Systems," Prentice Hall India Learning, 2015*
2. *Eds-Imdat As, Prithwish Basu , "The Companion to Artificial Intelligence in Architecture", , Routledge, 2021*
3. *Neil Leach , "Architecture in the Age of Artificial Intelligence-An Introduction to AI for Architects", Bloomsbury Visual Arts, 2021*
4. *D. Kolokotsa, "Artificial Intelligence in Buildings: A Review of the Application of Fuzzy Logic", Routledge, 2011*

Elective-IV (Semester 2)

AR450211 ***Assessment of Built Environment***	**L-T-P** **3-0-0** **3 credits**

Aim: To understand impacts and assessment of built environment and bench marking the sustainability of building.

Unit - 1

Evaluation of building performance. A conceptual framework for building performance evaluation.

Unit - 2

Performance assessment in different phases of building delivery & life cycle. Strategies planning & its effectiveness reviews, Program review, Design review, Construction /Commissioning, Post Occupancy evaluation, Adaptive reuse/Recycling/Market needs assessment.

Unit - 3

Benchmarking the sustainability of a building project case studies for e.g. office building, Institutional buildings.

Unit – 4

Evaluating universal design performance. Human element in building performance evaluation.

Unit - 5

Tools for building performance evaluation. Checklist, survey, Questionnaire.
Post occupancy evaluation of a building and document the relationship between building design, energy use, occupant satisfactory, environmental impact and report their observation.

Expected outcome: The course will give an overview and understanding of values and societal importance of the built environment, and the influence on a sustainable development.

Reference Books:

1. *Jane Jacobs, "The Death and Life of Great American Cities", Random House, 1961*
2. *Christopher W Alexander, Sara Ishikawa, Murray Silverstein, Max Jacobson; Ingrid Fiksdahl-King, Shlomo Angel, "A Pattern Language: Towns, Buildings, Construction", Oxford University Press, 1977*
3. *Arthur E Stamps, "Psychology and the Aesthetics of the Built Environment", Springer, 2000*
4. *Robert H Crawford, " Life Cycle Assessment in the Built Environment", Routledge, 2011*

Elective-IV (Semester 2)

AR450212 ***Energy Audit & Environmental Impact Assessment***	**L-T-P** **3-0-0** **3 credits**

Aim: To impart knowledge regarding the role of energy consumption in sustainable architecture.

Unit – 1

Definition, parameters and resources of sustainable architecture- land, energy, water, materials and environment; Introduction to rating schemes for sustainable architecture (LEED, GRIHA etc.) Energy cycle in the built environment; Importance of energy; Sources of energy- grid and off-grid (thermal, hydro, solar, gas, biomass) and energy use in buildings and settlements- lighting, ventilation, air conditioning, cooking, miscellaneous etc.

Unit – 2

Energy consumption in luminaries, HVAC, plumbing, transportation, various systems; Comparison of different technologies and systems for efficiency and performance. Energy audit of buildings- tools and techniques; Measurement and verification techniques; Benchmarking.

Unit – 3

ECBC, ASHRAE 90.1, ASHRAE fundamentals, Energy credits under rating schemes, techniques to achieve credits. Simulation tools for Whole Building Simulation as per ASHRAE 90.1 and ECBC.

Unit – 4

A detailed energy audit, quantify energy consumption and establish baseline energy information, Construct energy and material balance. Perform efficiency evaluation of energy & utility systems, Compare energy norms with existing energy consumption levels.

Unit – 5

Introduction and components such as physical, biological and socio-economical of Environmental impact assessment (EIA) in India based on the Environmental Protection Act (EPA), 1986, Ministry of Environment and Forest (MoEF) January 1994 for Environmental Clearance (EC) known as EIA Notification, 1994. Subsequent amendments.An appraisal of the EIA system against systematic evaluation criteria for various categories such as (i) Protected Areas notified under the Wild Life (Protection) Act,1972, (ii) Critically Polluted areas as notified by the Central Pollution Control Board from time to time, (iii) Notified Eco-sensitive areas, and (iv) inter-State boundaries and international boundaries and If any Industrial Estate/Complex/Export processing.

Expected outcome: The course provides the students with the knowledge base and knowledge of how to use and review energy consumption in the most environmental friendly way.

Reference Books:

1. *Moneef Krarti, "Energy Audit of Building Systems", CRC Press, 2000*
2. *ESRU, "ESP-r A Building Energy Simulation Environment; User Guide Version 9 Series."ESRU Manual U 96/1, University of Strathclyde, Energy Systems Research Unit,1996.*
3. *Kabele, K., "Modeling and analyses of passive solar systems with computer simulation", in Proc.Renewable energy sources, PP. 39 – 44, Czech Society for Energetics Kromeriz ,1998*
4. *Clarke, J.A., "Energy simulation in building design", Adam Hilger Ltd, 1985*
5. *Friedmann, A., Zimring, C. &Zube, E, "Environmental Design Evaluation", Plenum,1978.*

Elective-IV (Semester 2)

AR450213 ***Energy Efficient Building Design – Theory and Technologies***	**L-T-P** **3-0-0** **3 credits**

Aim: To provide knowledge and skills that will exhibit a low operating energy demand, especially for heating, cooling, and lighting.

Unit – 1

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

Unit – 2

Layout, Orientation, Surface Area/Volume Ratio, Zoning of Internal Spaces, Buffer Spaces, Location of Openings; Building surface and fabric: Insulation, color, window size location, and details; 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; Design of Shading Devices: fins, overhangs, pergolas, green roofs and walls, space frames, façade shading; Calculation and estimates of the effectiveness of the same (shadow angles, sun path analysis)

Unit – 3

Uniform Luminance Sky Distribution, CIE Standard Overcast Sky Distribution, Clear Blue Sky Distribution, Tropical Design Sky; Direct, diffuse and reflected components; Design Parameters: Glare, critical indoor and outdoor luminance, daylight factor and its calculation and distribution; Techniques of incorporating daylight in buildings.

Unit – 4

Passive and Low Energy Heating Systems, Principles and types: Direct Gain, Indirect Gain; Isolated Gain; Principles, advantages and disadvantages, control, and operating characteristics for each of the above systems

Unit – 5

Passive and Low Energy Cooling Systems (based on shedding heat to air; heat to evaporating water; heat to the ground; heat to the sky)

Expected outcome: The students will be capable with their advanced professional competence to significantly contribute and influence the design to achieve energy-efficient buildings and relating to renewable energy supply.

Reference Books:

1. *Ander, G. D., "Daylighting Performance and Design (second edition)", John Wiley & Sons Inc., 2003*
2. *Bureau of Indian Standards, "National Building Code of India, Part 8: Building Services, Section 1: Lighting and Ventilation", BIS, 2005*
3. *Crosbie, M. J., "The Passive Solar Design and Construction Handbook", John Wiley & Sons Inc., 1998*

Elective-V (Semester 2)

AR450221 ***Project Management & Finance***	**L-T-P** **3-0-0** **3 credits**

Aim: To enable the students to understand the Finance, Project Management along with the Architectural professional practice.

Unit – 1

Introduction to project planning, Historical development, concepts and management Life cycle of a project; Stages of project formulation and their significance - identification of a project, techno economic analysis, feasibility analysis, design and network analysis, Norms, standards, aspects and methods of project appraisal and report, cost-benefit analysis, discounted cash-flow analysis; costs of conducting such analysis. Project funding, economic feasibility and methods of recovery.

Unit - 2

Network techniques of project formulation - network logic, rules, forms of network, critical path method (CPM) & project evaluation and review technique (PERT); Time estimates and uncertainty; Work schedule- concepts & techniques. Implementation strategies, scheduling, activities, progress reviews, corrective actions etc.

Unit - 3

Project management software and its application, latest trend in construction project management.

Unit - 4

Introduction to finance: Principles of finance. Introduction to financial systems. Introduction to public financing.

Unit - 5

Basics of investment and financial decisions for infrastructure projects: Estimating the cost of project, Means and Sources of Finance, External and internal sources of financing, Requirements of external financing, Types of debts, Leasing, Basics of income expenditure and profit – loss, Tax and Depreciation. Special projects such as Special economic zones, export processing zones, townships etc. Mandatory legal and environmental approvals Case studies of successful projects and planning schemes are encouraged to be used as examples.

Expected outcome: Students will learn the tools and techniques for effective Project planning and management along with financial intricacies.

Reference Books:

1. *Chandra, P., "Projects: Preparation, Appraisal, Budgeting and Implementation.Vol.2",Tata McGraw-Hill, 1987*
2. *Chandra, P.,"Projects: Planning, Analysis, Selection, Financing, Implementation, and Review. Vol.8.", McGraw Hill, 2009*
3. *Emery, A.R., "Guidelines: integrating indigenous knowledge in project planning and implementation", The World Bank, 2000*
4. *Haugan, G.T., "Project planning and scheduling", Berrett-Koehler Publishers, 2001*
5. *James P Lewis, "Project Planning, Scheduling and Control", Tata Mcgraw-Hill, 2005*
6. *Loraine, R.K, "Construction Management in Developing Countries", Thomas Telford, 1993*
7. *H.L Ahuja, "Economic Environment of Business, Macro Economic Analysis", Tata Mac Grow Hill, 2001.*
8. *Richard Luecke, "Finance for Managers, Harvard Business Essentials", Harvard Business Review Press, 2002*
9. *Gupta, B.L. and Gupta, Amit., "Construction Management, Machinery and Accounts, 3rd ed", Standard Pub. 2005*

Elective-V (Semester 2)

AR450222 **Waste Management**	**L-T-P** **3-0-0** **3 credits**

Aim: To provide a comprehensive understanding of waste management from an environmental public health perspective.

Unit - 1

Public health, regulatory, planning, technical and economic principles that influence the solid waste management system.

Unit - 2

Methods to minimize the impact on the public's health from solid waste related activities.

Unit - 3

Analysis of an integrated solid waste handling system including source reduction, recycling and reuse, composting, land filling and combustion.

Unit - 4

Variety of waste related issues such as electronic waste, industrial waste, medical waste and C&D (construction and demolition) waste etc.

Unit - 5

Sustainable techniques in municipal solid waste management and others: Introduction, Segregation, Sorting, Composting, Vermi composting, Home composting, Recycling and Reuse. Incineration method, Scientific Land filling, Energy development and Management of urban waste services.

Expected outcome: Student will be able to identify and discuss the public health, regulatory, planning, technical, and economic principles that influence the waste management system.

Reference Books:

1. *Garg S K, "Sewage Disposal and Air Pollution Engineering", Khanna Publication, 2008*
2. *H.N. Tiwari, "Environmental Law", Allahabad Law Agency, 1997*
3. *Environmental, A., Divan and Noble M. "Environmental Law and Policy in India (cases, Materials and Statutes)" Tripathi 1991*
4. *J.N. Pandey, Constitutional Law of India (31st Edition.) Central Law Agency, 1997*

Elective-V (Semester 2)

AR450223 ***Construction Project Management***	**L-T-P** **3-0-0** **3 credits**

Aim: To impart the knowledge of the basics of project management in the field of construction industry.

Unit - 1

Construction and manufacturing industry; Construction project management concepts; Standards and services; Organizational hierarchy for project management services; Project life cycle.
Lean construction and process mapping; Management strategies for clients and stakeholders; Management issues related to construction project design process; Capital Budgeting.

Unit - 2

Project management evaluation; Tools/techniques for construction project planning (PERT & CPM) and control of costs, time, risk and quality; TQM, health and safety. Project Implementation , methods, hurdles, facilitating factors; Line management, the role of project manager.

Unit - 3

Relationship between projects and planning issues: market analysis, technical analysis; supporting infrastructure requirements; Social cost-benefit analysis.

Unit - 4

Contracts Act; Labour Regulations; Arbitration act; Developers bill; Environmental Management Plan (EMP); ISI standards and its application to the Indian context.

Unit - 5

Project management; Strategies and advancement; BIM, Lean construction- Toyota Production System, Just-in-time, value and waste; Maintenance of building elements; Facility Management.

Expected outcome: Make students understand the theory, methods and quantitative tools used to effectively plan, organize, and control construction projects with sustainable approach.

Reference Books:

1. *Harold Kerzner, "Project Management a Systems Approach to Planning Scheduling and Controlling", Wiley, 2019*
2. *Pierre-Jean Charrel, Daniel Galarreta, "Project Management and Risk Management in Complex Projects", Springer, 2010*
3. *Loraine, R.K, "Construction Management in Developing Countries". Thomas Telford, 1993*
4. *Srinath, L.S., "PERT and CPM Principles and Applications, 3rd ed". Affiliated East-West Press, 2003.*
5. *Hans Ottosson, "Practical Project Management for Building and Construction 1st Edition", Auerbach Publications, 2012.*
6. *Gould, E. Frederick and Joyce, E. Nancy., "Construction Project Management", Prentice-Hall, 2000*
7. *S. Keoki Sears, Glenn A. Sears, Richard H. Clough, Jerald L. Rounds, Robert O, "Construction Project Management, 6th Edition" Segner, 2015.*

Elective-VI (Semester 2)

AR450231 **Advanced Building Services**	**L-T-P** **3-0-0** **3 credits**
Aim: It aims to equipped students with advanced knowledge of various building services to be abreast with the latest technological.	

Unit – 1

Heating, Ventilation and Air Conditioning Systems its Components, Advanced HVAC technologies, systems and their application in Hospitals, Commercial, Residential, Malls.

Unit – 2

Human Comfort and Indoor Environmental Quality and its factors affecting the thermal comfort conditions and indoor air quality, importance of indoor air quality, Critical parameters, Environmental pollutants types and their impact on human health,

Unit – 3

HT & LT power distribution, power sub-station, emergency power, low voltage services – CCTV, Telephone, public address system, access control system, lighting control system, server and data system. Lighting Design: terminology, factors involving lighting design, day lighting and artificial lighting, lighting in different types of buildings, lighting simulations.

Unit – 4

Water and wastewater treatment: advanced water and wastewater treatment technologies. Fire Safety engineering: fire – causes, classification detection, and suppression; active and passive fire prevention techniques, means of escape,

Unit – 5

Advanced Building Acoustics: characteristics of sound, noise, measuring instruments, transmission of sound, good acoustics, acoustic materials and noise mitigation. Earthing and Lightening Protection: Lightening arresters

Expected outcome: The course enable students on basic skills at selecting solutions for various building services methods and to make them aware of the role of modern, highly effective technical solutions.

Reference Books:

1. *Benjamin Stein & John Reynold, "Mechanical and Electrical Equipment for Buildings", Wiley, 1999*
2. *Klaus Daniels, "Advanced Building Systems: A Technical Guide for Architects and Engineers", Birkhauser, 2003*
3. *Bureau of Indian Standards, "National Building Code of India", BIS, 2016*
4. *Heschong, Lisa; "Thermal Delight in Architecture", MIT Press, 1979*

Elective-VI (Semester 2)

AR450232 ***Public Space Infrastructure and Design***	**L-T-P** **3-0-0** **3 credits**

Aim: To analyses open spaces and integrate and develop understanding of relevant infrastructure.

Unit – 1

Introduction: space, public space; role of public space and trees in urban life, green infrastructure, social activities and their types, role of landscape design and planning, health and safety as important parameters, role of public space in creating active communities.

Unit – 2

The holistic approach of landscape ecology and its application in design of natural and urban landscapes/ecosystems; to promote interdisciplinary collaboration in landscape and urban design.

Unit – 3

Importance of landscape design in urban design by referring to historical and contemporary examples, study of open space- built form relationship; various typologies of open space systems at macro and micro level; elements and principles of landscape design.

Unit – 4

Expand design skills to address problems involving the creation of outdoor public space the use of landscape typologies to create diverse public spaces

Unit -5

The basic design of street typologies and transportation networks, and the use of street furniture, lighting, graphics, signage, and public art in enhancing the sense of place.

Expected outcome: Develop a systemic understanding of city through spatial analysis of multiple elements and principles.

Reference Books:

1. *Gehl Jan, "Life Between Buildings," Van Nostrand Reinhold Co., 1971*
2. *Henry F. Arnold, "Trees in Urban Design", Van Nostrand Reinhold Co., 1980*
3. *Marsh M. William, "Landscape Planning – Environmental Applications," John Wiley and Sons, 1981.*
4. *Singh Chhatar, WattasRajnish, DhillonHarjit Singh, "Trees of Chandigarh", B R Publishing Corp., 1998*

Elective-VI (Semester 2)

AR450233 *Mega Structures*	**L-T-P** **3-0-0** **3 credits**

Aim: To understand concepts and technologies for design and construction of megastructures.

Unit – 1

Evolution of Megastructures; physical planning considerations, novelty in materials and products in megastructures.

Unit – 2

Architectural design considerations for tallest, biggest and largest buildings; Space planning and design standards, environmental considerations, building byelaws and codes.

Unit – 3

New trends and techniques in application of structural principles, effect of various foundation settlements on the behaviour of super structure, concept of structure forms and their stability to various types of structures, RCC space frames and steel space structures and hyperboloid.

Unit – 4

Mechanical, Electrical, Fire-fighting and security, vertical transportation, HVAC, BAS and Parking; Codes for the services.

Unit – 5

Construction planning and management, equipment's, materials and construction techniques, prefabrication. Types of megastructures across the globe.

Expected outcome: The student will learn about the frame system, the structural element types and time-dependent behaviour of mega structures.

Reference Books:

1. *Viswanath, H. R., Tolloczko J.J.A. and Clarke J.N. , "Multi-purpose High Rise Towers and Tall Buildings", Taylor & Francis, 1997*
2. *Lawarance, W. C. L. and Daniel, C.W.H, "Planning Buildings for a High Rise Environment", Hong Kong University Press., 2000*
3. *Yit Lin Michael Chew, "Construction Technology for Tall Buildings", World Scientific Publishing, 2001*
4. *International Code Council , "International Building Code 2009", International Code Council, 2009*
5. *Mitchell, S. K., "Megastructures: The Tallest Buildings", Gareth Stevens, 2009*
6. *Graham, I., "Megastructures: Tallest, Largest, Biggest, Deepest", Firefly Books Limited., 2012*