Semester- 1

	COMPUTATIONAL AND PARAMETRIC DESIGN STUDIO

Course Code	2MDAC101	CIE Marks	50
Teaching Hours per semester (L:T:S)	14:14:56	Viva Marks	50
Total Hours of Pedagogy	180 Hours	Total Marks	100
Credits	6	Exam Hours	-

Course Learning objectives:

- To explore the inter-relationships between the contemporary mediums of digital design to digital production
- To use digital tools in creating the required outcome
- To understand the relation between the tools , process and the final product

Module-1

INTRODUCTION

The studio will focus on parametric design process and will demonstrate link between the employment of advanced Digital design tools and the realm of digital fabrication through a product design within an Architectural domain that will augment the character of a specific built environment

Teaching-Learning Process	***ICT and Digital support**: To introduce the advanced Digital tools, to make them understand the process and approach to computational design - Rhino*

Module-2

ANALYSIS OF DATA

Investigation into the inter-dependencies amongst definite factors like human ergonomics, explicit site information, specific programmatic data and the immediate environment and their analysis and synthesis.

Teaching-Learning Process	***Collaborative and Cooperative learning**: physical case studies* ***ICT and Digital support**: To introduce and understand different parameters and constraints to incorporate into the analysis and study of the project . power presentation for relevant studies and analysis*

Module-3

PRODUCT MORPHOLOGIES

Detailed digitized resultants of this analysis to be used as input parameters whose permutations and combinations that will facilitate the generation of different iterations for Product morphologies

Teaching-Learning Process	***ICT and Digital support**: To introduce the advanced Digital tools, to make them understand the process and approach to computational design - Rhino* ***Collaborative and Cooperative learning**: Analyse the digitized results and consider the input parameters for different iterations . to study the optimized result which further, facilitate the generation of different iterations for Product morphologies*.

Module-4

DIGITAL FABRICATION

To enhance digital fabrication skill set to engage the performative capabilities of one specific selection generated through the iterative process.

Teaching-Learning Process	***ICT and Digital support**: introduction to different fabrication tools .*

	Module-5	
	FINAL DESIGN The methodologies engaged in the program will necessarily explore the inter-relationships between performative designs, solid modelling and computer numerically controlled fabrication.	
	Teaching-Learning Process	***Collaborative and Cooperative learning***: *Students should work on final design portfolio*

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

CIE marks shall be awarded by a committee composed of Principal/Dean, PG Course Coordinator/HOD and Guide/Co-guide of the department. The CIE marks awarded for PSC (professional supportive course), shall be based on the progress of the student throughout the semester, presentation skills in seminars and submission of the report

Semester End Examination:

- The student needs to submit his/her report done throughout the semester, including the data collection for the Viva examination, at least one day prior to the Viva examination to the PG course coordinator/HOD.
- The Viva-voce will be evaluated by external examiners appointed by the University along with PG Course coordinator/ guide/ co-guide or an internal examiner..
- The viva-voce marks list generated is to be signed by both internal and external examiners and submitted to VTU in the sealed cover through the Principal of the institution.

Suggested Learning Resources:

Books

1. Mark Burry; Scripting Cultures
2. Casey Reas and Chandler McWilliams; Form+Code in Design, Art, and Architecture, Kostas Terzidis ; Algorithmic Architecture
3. John Frazer; Evolutionary architecture
4. Tomoko Sakamoto; From control to Design

Web links and Video Lectures (e-Resources):

- https://www.danieldavis.com/a-history-of-parametric/
- https://vdoc.pub/download/scripting-cultures-architectural-design-and-programming-53g6jiss52r0
- https://davidfrico.com/evolutionary-architecture-principles.pdf
- https://www.perlego.com/book/2388244/from-control-to-design-pdf

Skill Development Activities Suggested

Students will work on analytical and design projects of product design scale and produce the work in the following form Complete documentation with all necessary design abstracts, process trajectory, digital models, diagrams, drawings, illustrations and text in a printed format as well as a soft digital. Scaled model of the complete project.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Interpret the understanding of digital tools , process and outcome	L2
CO2	Understand the interdependency of different parameters	L2
CO3	Develop the different parameters , and apply them computationally	L3
CO4	To engage to test the performative capabilities of one specific selection generated through the iterative process.	L4
CO5	To understand solid modelling and fabrication process	L4

Program Outcome of this program. (CPM)

Sl. No.	Description	POs
1	Acquire outstanding fundamental knowledge in the field of computational design	PO1
2	Encompass the ability to work in collaboration with interdisciplinary teams.	PO2
3	Demonstrate creativity in the problem-solving process through professional quality graphic presentations and technical drawings.	PO3
4	Acquire outstanding knowledge and software skills for design and construction	PO4
5	Demonstrate design solutions that integrate contextual, social, economic, cultural, ethical, environmental concerns.	PO5

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5
CO1	0	M	M	H	H
CO2	L	M	H	M	L
CO3	0	M	M	H	H
CO4	0	M	M	L	H
CO5	L	L	M	M	H

H – High , M – Medium, L - Low

Semester - 1

ANALYTICAL DIAGRAMMING AND ARCHITECTURAL REPRESENTATION	

Course Code	2MDAC102	CIE Marks	50
Teaching Hours per semester (L:T:S)	28:00:28	Viva Marks	50
Total Hours of Pedagogy	120 Hours	Total Marks	100
Credits	4	Exam Hours	-

Course Learning objectives:

- To understand the potential of diagramming as an analytical as well as a representational tool inherent to parametric design process
- To use digital tools in creating the required outcome
- To understand the relation between the tools , process and the final product

Module-1

Understanding diagramming as an analytical and representational tool . User centric design ,New methods to understand and observe tangible and intangible elements of behaviour, design of building and organisation

Teaching-Learning Process	***ICT and Digital support****: To enhance the students' understanding of representation in architecture. To enable them to diagrammatically represent data - powerpoint*

Module-2

The history and evolution of diagramming in architecture. Design, technology and prototyping It focuses on advance skills of industry, ideation and processes using design analytics principles-architectural representation, data analysis (qualitative and quantitative - mapping,

Teaching-Learning Process	***Collaborative and Cooperative learning****: students can present their research and findings to class* ***ICT and Digital support****: To introduce and understand different parameters and constraints to incorporate into the analysis and study of the project . power presentation for relevant studies and analysis*

Module-3

DATA ANALYSIS

Developing the ability to sieve information and build effective and meaningful information on diagrams. to understand data and process information diagrammatically

Teaching-Learning Process	***ICT and Digital support****: introduce the excel tool for data and statistical analysis* ***Collaborative and Cooperative learning****: Analyse the digitized results and consider the input parameters for different iterations . to study the optimized result which further, facilitate the clean up of data*

Module-4

DIAGRAMMING REPRESENTATION

Exploring the usage of diagramming in professional international practices Use of program diagrams in the design process. To understand architecture in terms of diagrammatic representation - Bernard Tschumi

	Teaching-Learning Process	***ICT and Digital support****:To introduce them to strategies and tools enabling integrated design analytics.*
	Module-5	
	Introduction to Architectural representation platforms, post-production techniques and tools.	
	Teaching-Learning Process	***Collaborative and Cooperative learning****: Students can research and present their works to class*

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

CIE marks shall be awarded by a committee composed of Principal/Dean, PG Course Coordinator/HOD and Guide/Co-guide of the department. The CIE marks awarded for PSC (professional supportive course), shall be based on the progress of the student throughout the semester, presentation skills in seminars and submission of the report

Semester End Examination:

- The student needs to submit his/her report done throughout the semester, including the data collection for the Viva examination, at least one day prior to the Viva examination to the PG course coordinator/HOD.
- The Viva-voce will be evaluated by external examiners appointed by the University along with PG Course coordinator/ guide/ co-guide or an internal examiner..
- The viva-voce marks list generated is to be signed by both internal and external examiners and submitted to VTU in the sealed cover through the Principal of the institution.

Suggested Learning Resources:

Books

- Lankow, Jason (2012), Infographics: The Power of Visual Storytelling, Wiley S Sons Hoboken
- MVRDV (1999); Metacity/Datatown
- Tschumi, Bernard (2014); Notations: Diagrams and Sequences
- McCandless; David (2014), Knowledge is Beautiful
- Koolhaas, Rem (1999)

Web links and Video Lectures (e-Resources):

- https://www.pinterest.com/pin/25543922871651198/ ·
- https://www.pinterest.com/pin/615867317762664564/ ·
- https://openlab.citytech.cuny.edu/arch -1210-spring-2013/files/2011/06/Precedents-in-Architecture Analytic-Diagrams-Formative-Ideas-and-Partis.pdf ·
- https://www.researchgate.net/publication/297699713_Bernard_Tschumi_Draws_Architecture

Skill Development Activities Suggested

- Assignment will be in the form of notes/ assignments covering all the topics mentioned above with suitable examples, sketches and supportive material.
- Students will work on at least one project taken up in the design studio- I and work on conceptual evolution of design strategy through diagramming.
- Details of the project relating to all the above-mentioned topics will be submitted in the form of sheets and/or report and /or presentation

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	To understand spaces through, notations and diagrams	L2
CO2	Interpret the history and evolution of diagramming architecture	L2
CO3	To sieve information and build effective and meaningful information on diagram	L3
CO4	To demonstrate the use of design programs in representation	L4
CO5	students will be able to diagrammatically represent data and spaces .	L4

Program Outcome of this program. (CPM)

Sl. No.	Description	POs
1	Acquire outstanding fundamental knowledge in the aspect of diagramming	PO1
2	Encompass the ability to work in collaboration with interdisciplinary teams.	PO2
3	Demonstrate creativity in the problem-solving process through professional quality graphic presentations and technical drawings.	PO3
4	Students should be able to represent notationally architectural concepts	PO4

Mapping Matrix

	PO1	PO2	PO3	PO4
CO1	M	M	L	H
CO2	M	L	0	M
CO3	L	M	M	H
CO4	L	M	H	M
CO5	M	L	L	H

H- High , M- Medium, L - Low

Semester- 1

	DIGITAL ARCHITECTURE PROCESS THEORIES AND HISTORY -1

Course Code	2MDAC103	CIE Marks	50
Teaching Hours per semester (L:T:S)	42:00:00	SEE Marks	50
Total Hours of Pedagogy	90 Hours	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To develop a conceptual orientation for the historic trajectory and trace current process influences impact of digital technologies in architectural design
- To understand and trace the works of different architects , computationally
- To better understand the concept of parametric design

Module-1

Introduction to readings and discussions that trace the sociocultural and technological ferment of renaissance and neo- classical architecture. To understand the planning process of Marcus Vitruvius, Antonio Palladio , Leon Battista Alberti . This trajectory will trace the background of the past 20 years that was crucial for the formation of Digital Culture in architecture.

Teaching-Learning Process	***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation* ***Collaborative and Cooperative learning-** discussion and analysis based on the lecture*

Module-2

Introduction to research and analysis of Postmodernism and DEconstructivism movement. To understand the planning process, technical capabilities that brought a radical departure from traditional planning in architecture. Tracing the works of Peter Eisenman, Robert Venturi, Frank Gehry

Teaching-Learning Process	***Collaborative and Cooperative learning**: students can present their research and findings to class* ***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation*

Module-3

To trace the historical aspect and analysis of the following architects , for a better understanding of the generative and algorithmic approach to computational design . Daniel Libeskind , Mario Botto, Tadao Ando , Herzog de Mueron , Bernard Tschumi, Patrick Schumacher , Zaha Hadid

Teaching-Learning Process	***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation* ***Collaborative and Cooperative learning**: Analyse the different works-concepts of architects and discuss on the same*

Module-4

Introduction to the term- trans architecture , the meaning relevance and analysis in today's scenario , detailed study of concepts and works of Marcos Novak, Lars Spyubroek .

Teaching-Learning Process	***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation* ***Collaborative and Cooperative learning**: Analyse the different works-concepts of architects and discuss on the same*

	Module-5	
	Understanding and analysis of the virtual world, cyber space , virtual reality . to understand different computational installations and simulations . to understand the virtual world , possibilities and limitations.	
	Teaching-Learning Process	***Collaborative and Cooperative learning***: *Students can research and present their works to class*

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Continuous Internal Evaluation will be based on Assignments, Tests and Term Paper submission

Semester End Examination:

Theory Examination shall be held for 3-hour duration, students are expected to answer FIVE full questions, one question from each module

Suggested Learning Resources:

Books

1. Antoine Picon ; Digital Culture in Architecture
2. Ali Rahim; Contemporary Processes in Architecture
3. Rivka Oxman, Robert Oxman; Theories of the Digital in Architecture
4. Lise Anne Couture , Hani Rashid; Asymptote Architecture: Actualizations

Web links and Video Lectures (e-Resources):

- https://v2.nl/
- https://v2.nl/archive/people/marcos-novak
- https://www.nox-art-architecture.com/
- https://www.researchgate.net/publication/30873726_Parametric_Variations_of_Palladio's_Villa_Rotonda
- https://issuu.com/birkhauser.ch/docs/herzog-de-meuron-complete-works
- https://www.researchgate.net/publication/277899530_The_Parametric_Design_Genealogy_of_Zaha_Hadid

Skill Development Activities Suggested

To enable students to research and submit in the form of reports, discussions and debates. The outcome will also be in the form of individual perceptions on process theories through documentation and critical appraisals.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	To understand historically the parametric relevance	L2
CO2	Interpret the history and evolution of parametric architecture	L3
CO3	To sieve information and build effective and meaningful information	L2
CO4	To demonstrate the use of design programs in representation	L4
CO5	students will be able to better understand the concepts , for tool aided design	L4

Program Outcome of this program. (CPM)

Sl. No.	Description	POs
1	Acquire outstanding fundamental knowledge in history	PO1
2	Encompass the ability to work in collaboration with interdisciplinary teams.	PO2
3	Demonstrate creativity in the problem-solving process through professional quality graphic presentations and technical drawings.	PO3
4	Students should be able to these architectural concepts on to their design	PO4

Mapping of COS and POS

	PO1	PO2	PO3	PO4
CO1	M	M	H	H
CO2	M	M	L	H
CO3	M	M	M	H
CO4	L	M	M	H
CO5	M	M	L	H

H – High, M – Medium, L - Low

Semester- 1

DIGITAL FABRICATION AND MATERIAL COMPUTATION - I			
Course Code	2MDAC104	CIE Marks	50
Teaching Hours per semester (L:T:P)	28:00:28	Term work	50
Total Hours of Pedagogy	90 Hours	Total Marks	100
Credits	3	Exam Hours	-

Course Learning objectives (CLO):

The curriculum shifts from standard production methodologies to systemic workflows that blend raw manufacturing mechanics with generative material properties.

- **CLO 1**: Establish a comprehensive theoretical framework of digital fabrication by integrating systemic workflows, CAD/CAM pipelines, and automated manufacturing metrics.
- **CLO 2:** Foster advanced design research trajectories where tectonic form is generated out of the physical constraints, structural capacities, and manufacturing tolerances inherent to real materials.
- **CLO 3:** Introduce the core tenets of Material Computation—treating matter not as a passive medium molded by geometry, but as an active agent embedded with behavioral properties, geometric feedback, and responsive characteristics.

Module-1: Foundations of Digital Fabrication and Material Tectonics

Introduction to Epistemologies: Mapping the historical transition from CAD/CAM to automated material workflows; identifying the paradigm shift from representation to direct materialization.

- **The Fabrication Typology:** Detailed taxonomies of material processing:
  - Formative (molding, casting, thermoforming).
  - Subtractive (milling, turning, cutting).
  - Additive (layered material deposition).
- **Introduction to Material Computation:** Understanding material-driven design parameters. Synthesizing toolpath constraints with material properties (grain pattern, elastic deformation, moisture behavior, and anisotropy).
- **File-to-Factory (F2F) Frameworks:** Basic concepts of structural topology optimization, data translation, and vector-to-machine language transformations.

Teaching-Learning Process	***ICT and Digital support****: Lecture will be conducted , through the use ofpowerpoint presentation* ***Collaborative and Cooperative learning****- discussion and analysis based on the lecture*

Module-2: Vector Subtraction and Sheet Tectonics (CNC Cutting)

- CNC Routing Mechanics: Mechanical anatomy of 2D/2.5D Computer Numerically Controlled (CNC) systems. Understanding coordinate systems, feed rates, spindle speeds, depth of cut, and step-over parameters.
- Tectonic Jointing and Assemblies: Translating raw sheet materials into interlocking spatial systems. In-depth analysis of structural kerfing, press-fit joinery, finger joints, lap joints, and waddles. Addressing physical production errors like corner radiused bit bite (dog-bones and T-bones).
- Material Constraints: Comparative study of sheets under subtractive cutting: plywood, medium-density fiberboard (MDF), acrylics, non-ferrous metals, and engineered composites.
- Strategic Optimization: Analysis of tool nesting strategies, material yield calculation, kerf allowances, and localized structural performance under variable joint orientations.

Teaching-Learning Process	***ICT and Digital support****: Lecture will be conducted , through the use of powerpoint presentation* ***Collaborative and Cooperative learning****: students can do a fabrication model based on the same*

	Module-3: Subtractive Volumetric Computation (CNC Milling)
	• **Subtractive Mass Volumetrics:** Structural theory and kinematics of 3-axis CNC milling machines. Understanding tool path strategies: horizontal roughing, parallel finishing, pencil tracing, and pocketing. • **Subtractive Materiality:** Investigating behavioral characteristics of homogeneous vs. heterogeneous volumes under rotary tooling. Materials include high-density tooling boards, polyurethane foams, solid timber blocks, and soft stone composites. • **Tooling Metrics:** Systematic categorization of tooling ends (ball-nose, flat-end, V-bit, bull-nose mills) and their relationship to surface finish roughness, structural scallop height, and structural tool clearance. • **Material Performance Optimization:** Evaluation of structural surface topologies, directional toolpaths aligned to structural stresses, and surface finishing techniques.
	Teaching-Learning Process | ***ICT and Digital support****: Lecture will be conducted , through the use of power point presentation*
	Module-4: Thermal Subtraction and Advanced Additive Manufacturing
	• **Laser Processing Tectonics:** Engineering principles of laser cutting (CO2 and Fiber configurations). Thermal ablation parameters: wattage, frequency, focus depth, and speed. Material mapping of vector cutting vs. raster engraving across acrylic, paper, and timber veneers. • **Layer-by-Layer Additive Synthesis:** Thermodynamic principles of Fused Deposition Modeling (FDM) and Selective Laser Sintering (SLS). • **Additive Material Behaviors:** Evaluation of structural anisotropy in 3D-printed elements, layer adhesion dynamics, cooling warpage, and chemical support structures. • **Computational Optimization:** Custom toolpath generation (slicing variables, infill typologies, perimeter shell optimization) to convert passive geometries into structurally optimized components.
	Teaching-Learning Process | ***ICT and Digital support****: Lecture will be conducted , through the use of power point presentation* ***Collaborative and Cooperative learning****: students can do a fabrication model based on the same*
	Module-5: Non-Planar Subtraction and Robotic Materialization
	• **Advanced Non-Planar Kinematics:** Structural theory of 3-axis CNC machining over complex double-curved surfaces. Mapping spatial orientation challenges along variable heights. • **Material Computation on Complex Forms:** Computational strategy for aligning toolpath orientations to non-planar vector fields. Managing structural grain behavior and tension over complex forms. • **Tectonic Articulation:** Analysis of structural skin-and-frame architectures, variable-depth rustication panels, and casting molds for parametric concrete panels. • **Advanced Workflows:** Managing geometric feedback loops where digital simulations adapt dynamically to material deflections measured during physical production phases.
	Teaching-Learning Process | ***ICT and Digital support****: Lecture will be conducted , through the use of powerpoint presentation* ***Collaborative and Cooperative learning****: students can do a fabrication model based on the same*

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

CIE marks shall be awarded by a committee comprising of Principal/Dean, PG Course Coordinator/HOD and Guide/Co-guide of the department. The CIE marks awarded for PSC (professional supportive course), shall be based on the progress of the student throughout the semester, presentation skills in seminars and submission of the report

Semester End Examination:

- The student needs to submit his/her report done throughout the semester, including the data collection for the Viva examination, at least one day prior to the Viva examination to the PG course coordinator/HOD.
- The Viva-voce will be evaluated by external examiners appointed by the University along with PG Course coordinator/ guide/ co-guide or an internal examiner.
- The viva-voce marks list generated is to be signed by both internal and external examiners and submitted to VTU in the sealed cover through the Principal of the institution.

Suggested Learning Resources:

Books

- Lisa Iwamoto ; Digital Fabrications: Architectural and Material Techniques
- Luca Caneparo; Digital Fabrication in Architecture, Engineering and Construction
- Menges, A. : Material Computation: Higher Integration in Morphogenetic Design.
- Christopher Breorkram ; Material Strategies in Digital Fabrication
- Oxman, N. : Material Ecology. Museum of Modern Art.
- Sophia Vyozviti; Soft Shells: Porous and Deployable Architectural Screens
- Sophia V -yozviti; Folding Architecture
- Gramazio, F., S Kohler, M. : Made by Robots: Challenging Architecture. Architectural Design (AD), Wiley.
- Mark Burry Jordi BonetiArmengol, Jos Tomlow, Antoni Gaudi ; Gaudi: Unseen
- Dunn, N. : Digital Fabrication in Architecture. Laurence King Publishing

Web links and Video Lectures (e-Resources):

- **https://www.researchgate.net/publication/257314849_Digital_Fabrication**
- **https://www.researchgate.net/publication/242259668_Laser_Cutting_Machines_for_3D_Thin_Sheet_Parts**
- **https://www.youtube.com/watch?v=Ev-MM9cGKiQ**
- **https://www.youtube.com/watch?v=FNYEXjRmDtI**
- **https://www.youtube.com/watch?v=SIjUVCho_xU**
- Gramazio Kohler Research - ETH Zürich
- Institute for Computational Design and Construction (ICD) - University of Stuttgart
- MIT Media Lab - Mediated Matter Group
- An Introduction to Additive Manufacturing/3D Printing

Skill Development Activities Suggested

Students will demonstrate their proficiency through Model making Students will submit reports related to their process of fabrication and research in the related domain will be presented through documentation.

Course outcome (CO)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	To characterize central technologies in fabrication and material computation.	L2
CO2	Interpret algorithmic concepts and transfer them to physical material models.	L3
CO3	Critically review the shift to integrated digital fabrication and file-to-factory loops.	L3
CO4	To demonstrate multi-axis fabrication workflows in computational design.	L4
CO5	Students will be able to better understand the concepts , for tool aided design	L4

Program Outcome (PO) Mapping

Sl. No.	Description	POs
1	**Technology Aptitude:** Assess and select optimal combinations of fabrication technologies appropriate for specific architectural material design challenges.	PO1
2	**Interdisciplinary Synthesis :** Master the technical vocabulary required to collaborate effectively across manufacturing, material science, and robotic engineering domains.	PO2
3	**Critical Spatial Research:** Evaluate the theoretical shift toward material-driven morphology inside advanced design studios.	PO3
4	**Organizational / Production Acumen :** Analyze and coordinate logistical, material, and performance parameters within architectural workflows.	PO4

Mapping Matrix

Course Outcomes	PO1	PO2	PO3	PO4
CO1	**L**	**M**	**M**	**H**
CO2	**L**	**L**	**M**	**M**
CO3	**L**	**M**	**M**	**M**
CO4	**M**	**M**	**L**	**H**
CO5	**M**	**M**	**M**	**H**

H – High, M – Medium, L - Low

Semester- 1

PROFESSIONAL ELECTIVE-I			
Course Code	2MDAC105x	CIE Marks	100
Teaching Hours per semester (L:T:S)	42:00:00	Term work	-
Total Hours of Pedagogy	90 Hours	Total Marks	100
Credits	3	Exam Hours	-

Course Learning objectives (CLO):

The objective of this elective course is to allow the students to cover a varied spectrum of domains of investigation within the premise of digital architecture. This course seeks to posit the role of different experimental threads within the broader context of digital practice. Specifically, it introduces machine learning models, neural networks, and generative AI architectures as active engines for spatial synthesis, design optimization, and creative workflow exploration.

2MDAC105A - GENERATIVE AI AND MACHINE LEARNING IN DESIGN

Module-1: From Tradition to Intelligence: The Paradigm Shift in Design Systems

- **The Tradition of Computational Architecture:** Historical review of deterministic design methodologies: rules-based scripts, shape grammars, and early parametric frameworks.
- **The Artificial Intelligence Evolution:** The conceptual transition from explicit, rule-based algorithmic design (if-this-then-that) to inductive, data-driven machine learning systems.
- **Introduction to Core AI Architecture:** Demystifying Deep Learning, Neural Networks (NN), and Large Language Models (LLMs) within creative industries.
- **The Latent Space:** Conceptualizing structural design as a traversal through multi-dimensional mathematical spaces rather than direct geometric modeling.

Teaching-Learning Process	***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation*

Module-2: Neural Vision: Image Synthesis and Diffusion Models in Spatial Ideation

- **Generative Diffusion Engines:** Theoretical mechanics of diffusion models (e.g., Stable Diffusion, Midjourney) and their integration into early-stage concept development.
- **Advanced Prompt Engineering:** Semantic syntax structures, architectural style weights, and lighting tokens for spatial conditioning.
- **Controlled Image Generation:** Deep dive into neural network control layers (ControlNet). Utilizing explicit structural inputs—such as edge detection (Canny), depth maps, and structural line work—to drive design generation.
- **Workflow Ideation Integration:** Iterative architectural styling, fast material variation testing, and context-aware masterplan site rendering.

Teaching-Learning Process	***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation*

	Module-3: Structural Automation: Data-Driven Optimization and Predictive ML
	• **Predictive Machine Learning Modeling:** Training regression and classification models to solve real-world architectural challenges (e.g., predicting thermal comfort, indoor daylighting performance, or structural load behaviors). • **Multi-Objective Generative Design**: Blending algorithmic optimization tools (e.g., Grasshopper Discover, evolutionary solvers) with neural networks to find ideal structural shapes. • **Synthetic Dataset Management:** Techniques for generating, cleaning, labeling, and organizing architectural datasets (images, 3D meshes, spatial layout graphs) for custom ML model training. • **Performance Feedback Loops**: Utilizing machine learning to compress time-consuming environmental or physics simulations into instant, predictive feedback cycles.
	Teaching-Learning Process | ***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation*
	Module-4: Volumetric Learning: 3D Deep Learning and Spatial Layout Optimization
	• **3D AI Model Formats:** Understanding how machine learning processes physical space: 3D voxels, point clouds, mesh deformations, and Neural Radiance Fields (NeRFs). • **Automated Layout Generation:** Exploring Generative Adversarial Networks (GANs) and Graph Neural Networks (GNNs) for automated floor plan synthesis, urban programmatic massing, and optimal spatial adjacency tracking. • **Material and Assembly Prediction:** Using neural networks to predict material failures, structural deformation limits, and real-world assembly tolerances before physical manufacturing. • **Critical Design Limits:** Analyzing the technical limits of 3D AI generation, including low geometric precision and the challenges of direct translation into production-ready BIM models.
	Teaching-Learning Process | ***ICT and Digital support**: Lecture will beconducted , through the use of powerpoint presentation*
	Module-5: Physical-Virtual-Physical (PVP): AI Handshakes and Future Ecosystems
	• **The Physical-Virtual-Physical (PVP) Intelligent Loop:** Blending physical reality capture (laser scanning, photogrammetry) with AI classification models to automatically reconstruct and clean digital architectural models. • **Interoperable Workflows:** Developing integrated translation pipelines connecting text-to-image outputs, parametric curves (Rhino/Grasshopper), and relational construction databases (BIM). • **Immersive Human-AI Interactivity:** Investigating the future of design via co-creation interfaces, real-time interactive sketch loops, and voice-to-geometry generation systems. • **Ethics and Intellectual Property:** Navigating professional challenges including data sourcing ethics, model bias, creative ownership, and the evolving role of the architect.
	Teaching-Learning Process | ***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation*

Semester- 1

2MDAC105B - PERFORMANCE-DRIVEN DESIGN AND ENVIRONMENTAL SIMULATION

Course Code	2MDAC105B	CIE Marks	100
Teaching Hours per semester(L:T:S)	42:00:00	Term Work	-
Total Hours of Pedagogy	90 Hours	Total Marks	100
Credits	3	Exam Hours	-

Course Learning objectives (CLO):

The objective of this elective course is to allow the students to cover a varied spectrum of domains of investigation within the premise of digital architecture. This course seeks to posit the role of different experimental threads within the broader context of digital practice. Specifically, it introduces computational thermodynamic, solar, aerodynamic, and microclimate feedback engines as direct drivers for architectural form generation, morphology optimization, and envelope design.

Module-1: Theoretical Frameworks of Performative Tectonics and Climate Analytics

- **The Evolution of Performative Architecture:** Shifting from passive geometric representation to dynamic, performative material and spatial systems. Historical tracking of climate-responsive masterplans and bioclimatic building principles.
- **The Physics of the Built Environment:** Essential thermodynamic concepts—conductive, convective, and radiant heat transfers; psychrometric chart parameters, fluid mechanics, and atmospheric boundaries.
- **Climate Data Deconstruction:** Comprehensive analysis of EnergyPlus Weather (EPW) files. Translating solar position matrices, dry-bulb temperatures, wind velocity vectors, and relative humidity indices into direct design constraints.
- **Computational Integration Engines:** Introduction to multi-zonal simulation platforms, interface architectures, and algorithmic tool setups (e.g., Ladybug Tools, EnergyPlus, Radiance).

Teaching-Learning Process	***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation*

Module-2: Solar Morphologies and Daylight Optimization

- **Solar Radiation Scripting:** Parametric workflows to measure cumulative, direct, and diffuse radiation on complex building skins. Generating optimal massing orientations using solar radiation vectors.
- **Dynamic Daylighting Metrics:** Transitioning from static daylight factors to Climate-Based Daylight Modeling (CBDM). Scripting and tracking Useful Daylight Illuminance (UDI), Spatial Daylight Autonomy (sDA), and Annual Sunlight Exposure (ASE).
- **Glare and Visual Comfort Analytics:** Mapping Daylight Glare Probability (DGP) over changing seasons to prevent visual discomfort in complex spatial configurations.
- **Envelope Optimization Workflows:** Designing climate-responsive facades—such as parametric louvers, adaptive shading structures, and fritted glass patterns—driven directly by solar radiation profiles.

	Teaching-Learning Process	***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation*
	Module-3: Aerodynamics, Fluid Dynamics, and Urban Microclimates	
	• **Computational Fluid Dynamics (CFD):** Governing physics of outdoor air behavior around building shapes. Setting up computational boundary conditions, voxel grid networks, and roughness variables. • **Microclimate Tectonics:** Analyzing the Urban Heat Island (UHI) effect. Assessing Universal Thermal Climate Index (UTCI) metrics and outdoor thermal comfort variations across public plazas and pedestrian pathways. • **Natural Ventilation Strategies:** Simulating wind-driven stack effects, single-sided ventilation mechanics, and cross-ventilation behaviors inside variable indoor spatial volumes. • **Aerodynamic Design Formulations:** Designing building masses, internal atriums, and pressure-relieving voids optimized to mitigate structural wind drag and enhance natural fresh air circulation.	
	Teaching-Learning Process	***ICT and Digital support**: Lecture will be conducted , through the use of power point presentation*
	Module-4: Whole-Building Energy Modeling and Carbon Analytics	
	• **Thermal Zone Partitioning:** Establishing multi-zone configurations, internal load schedules (occupancy profiles, lighting, equipment power), and thermal boundary properties. • **Building Envelope Performance:** Calculating assembly values (U-values, R-values, Solar Heat Gain Coefficients) and evaluating transient thermal storage characteristics across layered materials. • **Operational Energy Prediction:** Simulating building energy use intensity (EUI), heating/cooling system loads, and building service operational performance. • **Life Cycle Carbon Assessment (LCA):** Balancing initial embodied carbon metrics in raw structural materials against long-term operational energy reductions to guide material selection.	
	Teaching-Learning Process	***ICT and Digital support**: Lecture will be conducted , through the use of power point presentation*
	Module-5: Evolutionary Optimization and Spatial Network Analysis	
	• **Multi-Objective Optimization Loops:** Setting up evolutionary solvers (e.g., Wallacei, Octopus) to manage conflicting performance goals, such as balancing maximized daylight access with minimized solar heat gains. • **Spatial Syntax and Network Analytics:** Evaluating urban spatial accessibility, pedestrian choice flows, and integration networks using space syntax modeling engines. • **The Computational Feedback Loop:** Designing automated systems where simulation readouts directly update parametric model scripts to continually refine the final building shape. • **Future Directions and Technical Limits:** Navigating limitations in simulation precision, checking computation speed trade-offs, and managing future climate model changes.	
	Teaching-Learning Process	***ICT and Digital support**: Lecture will be conducted , through the use of power point presentation*

Semester- 1

2MDAC105C - ROBOTIC FABRICATION AND AUTOMATED CONSTRUCTION

Course Code	2MDAC105C	CIE Marks	100
Teaching Hours per semester(L:T:S)	42:00:00	Term work	-
Total Hours of Pedagogy	90 Hours	Total Marks	100
Credits	3	Exam Hours	-

Course Learning objectives (CLO):

The objective of this elective course is to allow the students to cover a varied spectrum of domains of investigation within the premise of digital architecture. This course seeks to posit the role of different experimental threads within the broader context of digital practice. Specifically, it introduces multi-axis industrial kinematics, robotic toolpath programming, and automated assembly systems as active drivers for physical materialization, tectonic assembly, and novel structural configurations.

Module-1: Kinematic Frameworks, Robotic Anatomy, and Path Interoperability

- **The Shift to Industrial Automation:** Tracing the transition from 3-axis CNC machines to multi-axis industrial arm configurations (6+ axes) within contemporary spatial practice.
- **Robotic Anatomy and Coordinate Systems:** Anatomy of a robotic arm: links, joints, payload capacities, and reach. Demystifying coordinate systems: World, Base, Tool (TCP - Tool Center Point), and User Coordinate Systems.
- **Kinematics and Workspace Envelopes:** Differentiating Forward Kinematics (FK) from Inverse Kinematics (IK). Identifying spatial boundaries, target reach, singularity zones, and axis limits.
- **Computational Control Environments:** Introduction to file-to-factory data translation pipelines using visual programming plugins (e.g., KUKA|prc, Robots in Architecture, RoboDK) to output machine-specific code (KRL, RAPID).

Teaching-Learning Process	***ICT and Digital support****: Lecture will be conducted , through the use of powerpoint presentation*

Module-2: Robotic Material Deposition and Additive Assembly Systems

- **Continuous Additive Extrusion:** Computational pipelines for robotic material deposition. Mechanics of custom end-effectors for fluid materials (concrete, clay, bio-composites, recycled polymers).
- **Automated Material Feed Loops:** Syncing robotic movement speeds with material extrusion pump rates. Setting fluid material parameters: viscosity, setting times, slump behavior, and structural layer bonding.
- **Non-Planar Additive Workflows:** Moving beyond horizontal slicing to script spatial toolpaths that follow complex 3D contours and curves.
- **Optimized Forms:** Designing spatial structures—like self-supporting vaults, custom acoustic panels, and variable-density walls—optimized for programmatic material deposition.

Teaching-Learning Process	***ICT and Digital support****: Lecture will be conducted , through the use of powerpoint presentation*

	Module-3: Automated Subtractive Processing and Multi-Axis Machining
	• **Multi-Axis Subtractive Volumetrics:** Advanced kinematics of 6-axis milling, wire-cutting, and abrasive tooling. Programming multi-axis toolpaths for complex geometries. • **Subtractive End-Effectors:** Tool options for rotary cutting, hot-wire foam cutting, and automated saw blades. Tool configurations for surface scallop reduction and clearance angles over steep slopes. • **Material Properties Under Advanced Machining:** Processing timber blocks, high-density foam molds, and composite assemblies under variable cutting feeds and spindle speeds. • **Material-Driven Design Optimization:** Designing complex formwork molds, rusticated panels, and articulated joints shaped around specific cutting tool parameters.
	Teaching-Learning Process — ***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation*
	Module-4: Robotic Assembly, Kinematic Pick-and-Place, and Adaptive Tectonics
	• **Spatial Pick-and-Place Frameworks:** Computational setup for automated sorting, picking, placing, and fixing discrete building elements (bricks, timber struts, acoustic tiles). • **End-Effector Integration:** Mechanics of vacuum grippers, mechanical claws, and custom pneumatic holding tools configured for varying component weights. • **Robotic Joinery and Fixing Systems:** Integrating automated glue dispensing, mechanical fastening, or automated welding tools during spatial assembly loops. • **Material Precision and Feedback Control:** Managing accumulation errors in physical components. Introducing basic sensory feedback systems to adjust robot movements to material variations.
	Teaching-Learning Process — ***ICT and Digital support**: Lecture will be conducted , through the use of power point presentation*

	Module-5: Mobile On-Site Automation, Digital Twins, and Future Ecosystems
	• **On-Site Autonomous Construction:** Transitioning from factory workshops to on-site robotic deployment. Introduction to mobile multi-axis systems, automated layout tools, and drone-assisted assemblies. • **Robotic Reality Capture Integration:** Combining real-time 3D laser scanning and depth sensors with robotic path tracking to match digital layouts with physical site conditions. • **The Living Digital Twin Interface:** Managing real-time bidirectional data streams connecting physical industrial systems with their virtual computational models. • **Technical Constraints and Safety:** Evaluating safety zones, workspace protocols, technical limits of automated systems, and the evolving role of the architect in automated construction.
	Teaching-Learning Process — ***ICT and Digital support**: Lecture will be conducted , through the use of power point presentation*

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

CIE marks shall be awarded by a committee comprising of Principal/Dean, PG Course Coordinator/HOD and Guide/Co-guide of the department. The CIE marks awarded for PSC (professional supportive course), shall be based on the progress of the student throughout the semester, presentation skills in seminars and submission of the report

Semester End Examination:

- The student needs to submit his/her report done throughout the semester, including the data collection for the Viva examination, at least one day prior to the Viva examination to the PG course coordinator/HOD.
- The Viva-voce will be evaluated by external examiners appointed by the University along with PG Course coordinator/ guide/ co-guide or an internal examiner..
- The viva-voce marks list generated is to be signed by both internal and external examiners and submitted to VTU in the sealed cover through the Principal of the institution.

Suggested Learning Resources:

Core Reference Books

- Gramazio, F., S Kohler, M. (2008). *Digital Materiality in Architecture*. Lars Müller Publishers.
- Gramazio, F., Kohler, M., S Langenberg, S. (2014). *Fabricating Architecture: Selected Readings in Digital Design and Manufacturing*. John Wiley S Sons.
- Menges, A., Schwinn, T., S Krieg, O. (2016). *Advancing Wood Architecture: A Computational Approach*. Routledge.
- Dörfler, K., Hack, N., Sandy, T., Giftthaler, M., Marcari, M., Kohler, M., Gramazio, F., S Buchli, J. (2016). *Mobile Robotic Fabrication on Construction Sites*. Wiley.
- Reinhardt, D., Saunders, R., S Burry, J. (2016). *Robotic Fabrication in Architecture, Art and Design*. Springer.
- Yuan, P. F., Menges, A., S Leach, N. (2022). *Robotic Fabrication in Architecture: Proceedings of the Rob|Arch Conference*. Springer.

Web links and Video Lectures (e-Resources)

- Association for Robots in Architecture (Rob|Arch Network)
- ETH Zürich - Gramazio Kohler Research Database
- University of Stuttgart - Institute for Computational Design and Construction (ICD)

Skill Development Activities Suggested

Assignment will be in the form of in depth documentation subsequent to the study of a topic related to any one of the subject based on availability of experts, which will be presented by the student in the form of a documented report , and a presentation on the same.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	To characterize central concepts of multi-axis kinematics, coordinate systems, and robotic tool parameters.	L2
CO2	Enable students to understand limitations in shifting from 3-axis CNC systems to multi-axis automated robotic construction.	L2
CO3	To develop skills in qualitative and quantitative toolpath data analysis, code compilation, and spatial movement mapping.	L3
CO4	To develop advanced understanding of algorithmic path generation, material extrusion control loops, and assembly metrics.	L3
CO5	To critically interpret and apply robotic manufacturing workflows toward resolved building forms, component connections, and automated setups.	L4

Program Outcome (PO) Mapping

Sl. No.	Description	POs
1	**Theoretical Relevance :** Understand the core historical and contemporary relevance of industrial automation, machine control, and robotic fabrication within architectural theory.	PO1
2	**Workflow Limitations :** Gauge and document the physical limits, kinematics restrictions, and error variables when transitioning from digital scripts to real-world machine output.	PO2
3	**Data Synthesis :** Understand and master qualitative and quantitative machine code optimization, axis trajectory tracking, and performance validation data.	PO3
4	**Computational Application :** Develop a deep understanding of automated design exploration, end-effector configuration, and functional manufacturing metrics.	PO4
5	**Critical Structural Interpretation :** Critically interpret, evaluate, and integrate robotic manufacturing outcomes with real-world architectural design and construction delivery.	PO5

Mapping of COS and POS

	PO1	PO2	PO3	PO4	PO5
CO1	H	M	L	M	H
CO2	L	H	M	M	H
CO3	L	M	M	M	H
CO4	M	L	M	M	M
CO5	L	L	M	M	H

H – High, M – Medium, L - Low

Semester- 1

BIM AND INTEGRATED WORKFLOWS	

Course Code	2MDAC106	CIE Marks	50
Teaching Hours per semester (L:T:P)	14:00:56	Viva marks	50
Total Hours of Pedagogy	90 Hours	Total Marks	100
Credits	3	Exam Hours	-

Course Learning objectives (CLO) :

The subject aims to introduce students to associative parametric information modeling frameworks and integrated project delivery systems, serving as both an iterative methodology for multi-disciplinary coordination and an advanced environment for automated data management across a project's lifecycle.

Module-1: Strategic Frameworks, Lifecycle Information, and Global Standards

- **Information Modeling Foundations:** Evolution from legacy CAD representation to object-based parametric information modeling. Defining BIM dimensions: 3D geometry, 4D Scheduling, 5D Cost, 6D Sustainability and 7D Asset Management.
- **International Frameworks and ISO 19650:** In-depth breakdown of the ISO 19650 series. Understanding OIR (Organizational Information Requirements), AIR (Asset Information Requirements), EIR (Exchange Information Requirements), and BEP (BIM Execution Plans - Pre and Post-Contract).
- **The Common Data Environment (CDE):** Structural architecture of a CDE. Information status gates: WIP (Work in Progress), Shared, Published, and Archived. Managing metadata, revision controls, and digital sign-off protocols.
- **Levels of Development and Information:** Navigating Level of Development (LOD 100 to LOD 500), separating Level of Geometry (LOG) from Level of Information (LOI) to establish clear delivery metrics.

Teaching-Learning Process	***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation* ***Collaborative and Cooperative learning-** discussion and analysis based on the lecture*

Module-2: Object Authoring, Parametric Architecture, and Open BIM Interoperability

- **Parametric Information Architecture:** Advanced compilation mechanics within industry-standard authoring platforms (e.g., Autodesk Revit, Graphisoft Archicad). System families, loadable family creation, nested components, adaptive components, and types.
- **Host Relations and Shared Parameters:** Constraining geometries through mathematical parameters, setting up custom parameter schemas (Project, Shared, Global parameters), and establishing dynamic scheduling relationships.
- **Interoperability and open BIM:** Industry Foundation Classes (IFC) data schema structures, property set (Pset) mapping, and translation workflows.
- **BIM Collaboration Format (BCF):** Implementing open communication standards for structural, spatial, and mechanical model coordination across diverse software platforms.

Teaching-Learning Process	***ICT and Digital support**: Lecture will be conducted , through the use of powerpoint presentation* ***Collaborative and Cooperative learning**: students will be given exercises to do in class*

	Module-3: Federated Assemblies, Spatial Coordination, and Asset Handover
	• **Model Aggregation and Federation:** Methodologies for compiling distinct multi-disciplinary models (Architecture, Structure, MEP) into a single federated project environment. Coordinate system synchronization (Shared Coordinates, Survey Points, Project Base Points). • **Automated Spatial Coordination:** Algorithmic clash detection protocols using validation engines (e.g., Navisworks, Solibri). Distinguishing hard, soft, and clearance clashes. Matrix configuration, tolerance testing, and automated issue tracking. • **Information Validation:** Auditing model parameters for data completeness. Quality assurance workflows ensuring model compatibility with design intent and building codes. • **Data Delivery for Operations:** Preparing models for facilities management. Structuring Construction Operations Building Information Exchange (COBie) data sheets and linking asset models to computerized maintenance systems.
	Teaching-Learning Process | ***ICT and Digital support***: *Lecture will be conducted , through the use of powerpoint presentation*
	Module-4: Integrated 4D/5D Analytics and Computational BIM Scripting
	• **Time and Cost Phasing (4D and 5D):** Integrating work breakdown structures (WBS) with structural model elements. Simulating construction sequencing (4D) and extract automated quantities for continuous cost estimating (5D). • **Computational BIM and Visual Scripting:** Leveraging visual scripting platforms (e.g., Dynamo, Grasshopper for Revit) to automate repetitive modeling workflows, reorder parameter values, and manage complex parameter data sets. • **Algorithmic Geometry Generation:** Driving complex, adaptive building skins and variations within a BIM authoring environment using external computational data streams. • **Environmental Data Performance Integration:** Extracting structural solar, daylighting, and spatial energy parameters directly from coordinated models to optimize sustainable architectural outcomes.
	Teaching-Learning Process | ***ICT and Digital support****: Lecture will be conducted , through the use of powerpoint presentation* ***Collaborative and Cooperative learning***: *students can do a fabrication model based on the same*
	Module-5: Spatial Infrastructures, Digital Twins, and Future Ecosystems
	• **Macro-Scale Integration (BIM + GIS):** Combining building information models with Geographic Information Systems (GIS) to analyze urban scales, environmental impacts, and context relationships. • **Reality Capture Frameworks**: Introduction to Scan-to-BIM workflows. Registering point cloud data from terrestrial laser scanners or drones, assessing geometric tolerances, and generating accurate as-built models. • **Immersive Interactive Environments:** Exporting integrated information models into Virtual Reality (VR) and Augmented Reality (AR) platforms for design validation and site inspections. • **Digital Twins and Emerging Horizons:** Transitioning from static models to live Digital Twins using realtime IoT (Internet of Things) sensor feeds, predictive maintenance modeling, and AI-driven spatial optimizations.
	Teaching-Learning Process | ***ICT and Digital support****: Lecture will be conducted , through the use of powerpoint presentation* ***Collaborative and Cooperative learning***: *students can do a fabrication model based on the same*

Assessment Details (both CIE and SEE)

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- The viva-voce marks list generated is to be signed by both internal and external examiners and submitted to VTU in the sealed cover through the Principal of the institution.

Suggested Learning Resources:
Core Reference Books

- Eastman, C., Teicholz, P., Sacks, R., S Liston, K. (2018). BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers. John Wiley S Sons.
- Kensek, K. M. (2014). Building Information Modeling: BIM in Current and Future Practice. Routledge.
- Deutsch, R. (2011). BIM and Integrated Design: Strategies for Architectural Practice. John Wiley S Sons.
- Hardin, B., S McCool, D. (2015). BIM and Construction Management: Proven Tools, Methods, and Workflows. Sybex.
- Sacks, R., Brilakis, I., Pikas, E., S Xie, H. (2020). Construction 4.0: Advanced Technology, Tools and Processes for the Transformation of the AEC Industry. Routledge.

Web links and Video Lectures (e-Resources):

- Introduction to BIM Fundamentals and ISO 19650 Standards Fundamentals of BIM
- buildingSMART International - openBIM Standards
- Autodesk University - Advanced BIM Architecture & Dynamo Workflows

Skill Development Activities Suggested

- Specific software submissions in the form of process tutorial output will be submitted individually by every student.
- Students will develop their BIM understanding through different exercises and also students will work on at least one project taken up in the design studio- I and work on digital details of the project relating to all the above mentioned topics in the form of sheets and /or report.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	To characterize central information architectures, data metrics, and global ISO standards in BIM.	L2
CO2	Interpret complex multi-disciplinary data sets and transfer them into federated coordination models.	L3
CO3	Critically review the shift from legacy drafting representation to integrated lifecycle workflows.	L4
CO4	To demonstrate parametric model authoring, visual scripting automation, and collaborative coordination platforms.	L4
CO5	Formulate, audit, and troubleshoot cross-platform data schemas using openBIM interoperability protocols.	L4

Program Outcome (PO) Mapping

Sl. No.	Description	POs
1	**Critical Evaluation :** Possess the critical skills necessary to question the limits, data structures, and biases of a software interface.	PO1
2	**Interdisciplinary Collaboration :** Encompass the ability to work in seamless collaboration with interdisciplinary engineering and management teams.	PO2
3	**Application to Practice :** Critically review and assess the software interface and apply it directly to complex architectural design execution.	PO3
4	**Generative Sensibility :** To develop a unique sensibility for generative, data-driven, and algorithmic modeling within structured database systems.	PO4
5	**Computational Tool Mastery :** To enable students to master parametric tools that directly support advanced computational design and delivery. To able the students in the better understanding of tools that aid in computational design	PO5

Mapping of COS and POS

Course Outcomes	PO1	PO2	PO3	PO4	PO5
CO1	**M**	**M**	**H**	**H**	**M**
CO2	**M**	**M**	**L**	**M**	**H**
CO3	**H**	**H**	**M**	**L**	**H**
CO4	**M**	**M**	**M**	**M**	**H**
CO5	**L**	**L**	**L**	**M**	**H**

H – High, M – Medium, L - Low

— — — END OF SEMESTER — — —