3.0 PROGRAM CONTENT

FIRST YEAR / SEMESTER ONE

INTEGRATED SUSTAINABLE PROJECT- I

COURSE CODE: SD 6501 **COURSE CREDITS: 07**

COURSE INTENT:

This course aims to promote awareness and understanding of sustainable building design and to design through resource-efficient architecture. This course will focus on the fundamentals of sustainable site context, energy and resource efficiency measures through the design of small to medium-scale building projects such as multifamily residential projects of scale up to 2000 sq. m.

COURSE CONTENT:

Introduction to sustainable and green buildings, benefits, benchmarks, and design approaches. Introduction to climate, passive design of building form, and envelope on daylight and heat load. Introduction to the effect of active equipment, lighting, HVAC, and Controls on building energy performance. Introduction to the implementation of photovoltaics in buildings. Introduction to the implementation of water and material efficiency strategies in buildings, introduction to pay-back analysis, and making a business case.

Implementation of the above ideas and strategies through a small to medium-scale building project.

COURSE OUTCOME:

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

CO1 : Identify sustainable and green features for the project.

CO2: Make use of systematic approach for designing the project.

CO3: Analyse the impact of design strategies on energy, water, and material consumption using calculation and simulation.

CO4: Examine the design strategies and their relative cost-benefit implications.

CO5: Recommend design strategies and choices effectively as a business case to the client.

REFERENCES:

1. International Finance Coorporation. (2024). IFC Design for Greater Efficiency (DfGE).
2. International Finance Coorporation. (2024). IFC App [Software].
3. Indian Green Building Council (IGBC). (2019). IGBC New Homes Rating System.
4. The Energy and Resources Institute (TERI). (2019). GRIHA Manual 2019.
5. Lechner, N. (2021). Heating, Cooling, Lighting: Sustainable Design Strategies Towards Net Zero Architecture (5th ed.). Wiley.
6. DeKay, M. (2014). Sun, Wind, and Light: Architectural Design Strategies. Wiley.

THERMAL PERFORMANCE IN BUILT ENVIRONMENT

COURSE CODE: SD 6503 **COURSE CREDITS: 05**

COURSE INTENT:

This course will provide a fundamental understanding of building physics through the study of the interactions between heat, moisture, and air transfer between indoor and outdoor environments including the building envelope and its occupants. The course will be based on a set of numerical problems and tools to elucidate ideas related to building physics to regulate heat load acceptable by the prevalent regulatory sustainability and energy codes towards enabling a thermally comfortable and energy-efficient built environment.

COURSE CONTENT:

Introduction to building physics (heat, moisture, and air transfer) and thermal comfort. Introduction to heat balance of the human body and its role in achieving thermal comfort. Effect of building wall insulation on human thermal comfort. Effect and importance of building wall insulation on U-value/heat transfer in the absence and presence of solar radiation. Effect and importance of providing insulation in the roof on heat transfer and inner surface temperature. Effect of airtightness of the building structure on cooling load. Effect of wind speed on heat transfer through insulated and uninsulated building walls. Introduction to the concept of radiation shield in temperature measurement. Effect of building orientation on incident solar radiation and cooling load. Introduction to the concept of solar heat gain coefficient (SHGC) and effective SHGC. Effect of wall location and time of the day on the of sol-air temperature. Impact of window-to-wall ratio on overall heat transfer through a building envelope. Demonstrating the effectiveness of radiant cooling technique to achieve human thermal comfort in buildings. Introduction to the concept and importance of external shading in windows. Identification of the best method for reducing heat transfer through the window between an external shading system and a double-pane glass window. Introduction to the importance of set-point temperature in conventional air-conditioning systems and its effect of building energy consumption.

COURSE OUTCOME:

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

CO1: Understand the fundamentals of building physics (heat, moisture, and air transfer) and thermal comfort.
CO2: Solve problems related to heat conduction and the built environment.
CO3: Solve problems related to heat convection and the built environment.
CO4: Solve problems related to heat radiation and the built environment.
CO5: Solve problems related to multimodal heat, moisture, and air transfer and the built environment.

REFERENCES:

1. Carl-Eric Hagentoft, Introduction to Building Physics, Ligthning Source, 2001
2. Udayraj, Building Heat Transfer – Understanding through numerical examples, BEEP Project, Bureau of Energy Efficiency, Ministry of Power, Government of India, 2021

SUSTAINABLE LIGHTING & VISUALIZATION
(THEORY AND VR LAB)

COURSE CODE: SD 6505 **COURSE CREDITS: 03**

COURSE INTENT:

To develop an advanced understanding of basic science related to Illumination, daylighting & artificial lighting.

COURSE CONTENT:

Terminologies related to light. Introduction to technical and practical aspects of light. Exploration of fundamental design components involving spatial composition, color, form, contrast, pattern, material, and texture in conjunction with electric lighting and interior space. Illumination: Basic terminology and definitions, laws of illumination, Illumination requirements Classification of lighting systems: direct, indirect, diffused, etc. Daylighting: getting familiar with the recommended values of illumination and limiting values of glare index for different types of spaces; Introduction to Daylight and Glare analysis metrics. Explaining the latest and widely used metrics in detail. Design issues; Lighting for specific purposes; Interior lighting, Exterior lighting, Detailing & specification of lighting for Interior spaces: Detailing & specification of lighting for Exterior spaces. Application of knowledge to design and develop daylighting strategies and lighting schemes and visualize the outcomes using VR technology.

COURSE OUTCOME:

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

CO1: Understand terms & terminologies related to lighting (Daylighting and Artificial)

CO2: Discuss basic science related to Illumination.

CO3: Identify the needs of daylighting.

CO4: Measure the real time daylight and evaluate the simulation model.

CO5: Design, develop and visualize daylight strategies and lighting schemes by applying fundamentals of natural & artificial lighting.

REFERENCES:

1. BIS (Bureau of Indian Standards). (1987). Handbook on Functional Requirements of Buildings (Other than Industrial Buildings).
2. Ganslandt, R., & Hofmann, H. (1992). Handbook of lighting design. Braunschweig: Vieweg-Verlag.

RESEARCH METHODOLOGY

COURSE CODE: **SD 6507** **COURSE CREDITS: 04**

COURSE INTENT:

To equip students with the research methods, tools and techniques to undertake research in Sustainable Design.

COURSE CONTENT:

Basic Concepts and Research Process: Domain of research; Understanding the nature of research in Built Environment- Need & significance; Objectives; Characteristics; Ethics – Responsible conduct of research; Concepts of theory, data and reference management tools. Research methods in Built Environment – Types of Research; Research methods & Research methodology; Review of literature; research gap. Research design – Need for research, develop the research question, hypothesis, research methodology, scope and limitations. Data collection and analysis – Primary and secondary data collection, survey, observation, case study, post-occupancy evaluation, behavioural mapping, tracking, documentation and interpretation, selection of respondents and sampling procedures, techniques of analysis. Use of software in analysis, presentation and interpretation methods and techniques. Technical writing: Technical writing of research reports, publications, and proposals.

COURSE OUTCOME:

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

CO1: Explain the basic concepts and understand the characteristics of research.

CO2: Identify the research methods in built environment.

CO3: Evaluate the procedure for hypothesis

CO4: Analyse the data collection and sampling methods and illustrate the method of data collection.

CO5: Propose and communicate a feasible research report.

REFERENCES:

1. Dr.Ranjit Kumar, Research Methodology; A Step-by-Step Guide for Beginners, SAGE, 2005.
2. Lucas R., (2016) Research Methods for Architecture, Laurence King Publishing.
3. John W.Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods approaches, SAGE, 2004.
4. C.R.Kothari, Research Methodology; Methods and Techniques, new Age International Publisher, 2008.
5. R.Pannershelvam, Research Methodology, Prentice Hall, India, 2006.
6. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.

DATA SCIENCE & ANALYTICS

COURSE CODE: SD 6509 **COURSE CREDITS: 03**

COURSE INTENT:

This course will help in understanding the importance of data analysis and optimization in optimum decision making in architecture.

COURSE CONTENT:

Interpretation of relationships considering variables from the field of architecture, Maxima and minima of functions; Excel function, LP, optimization; Introduction to computer programming, flow chart/pseudo-codes, cleaning and transformation of data sets; Exercises on Data analysis from architectural examples: Problem-solving in architecture using linear/non-linear programming, evolutionary optimization etc., data analysis using excel and programming language; Data Visualization: Various types graphing, chart types to model and visualize data.

COURSE OUTCOME:

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

CO1: Interpret the relationships considering variables from the field of architecture.

CO2: Understanding of Excel and data analysis.

CO3: Understanding of computer programming and data analysis.

CO4: Model data driven scenarios for decision making and optimization in architectural design process.

CO5: Plan data visualization as reports to generate inferences for decision making.

REFERENCES:

1. Radford, A. D., & Gero, J. S. (1987). Design by optimization in architecture, building, and construction. John Wiley & Sons, Inc. (721.0281519 RAD).
2. Williams, H. P. (2013). Model building in mathematical programming. John Wiley & Sons. (519.7 WIL)
3. S Skiena, S. (2008). The Algorithm designs. Manual 2nd edition, Springer, Verlag London. (005.1 SKI)

FIRST YEAR / SEMESTER TWO

INTEGRATED SUSTAINABLE PROJECT- II

COURSE CODE: SD 6502 **COURSE CREDITS: 07**

COURSE INTENT:

This course aims to develop a practical understanding of designing passive environmental control systems for sustainable building through designing a medium-scale project of dominating external heat load typology of up to 5000 sq.m.

COURSE CONTENT:

This proposed studio will focus on climate responsive strategies to reduce the energy demand of buildings majorly through passive thermal and daylighting strategies by applying them into a design studio project. The outcome of studio shall focus on increasing its energy performance by intervening strategies including site and envelope design, design of various passive environmental control systems for passive heating, cooling, ventilation, daylighting using simulation, Post occupancy evaluation with real time measurements/ surveys, and cost benefit analysis.

COURSE OUTCOME:

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

CO1: Understand the context of project

CO2: Identify the need of different passive strategies for demand reduction.

CO3: Analyse the passive strategies to improvise the design.

CO4: Evaluation of passive strategies.

CO5: Propose comprehensive strategies for improved the performance of the project.

REFERENCES:

1. Majumdar, M. (Ed.). (2001). Energy-efficient buildings in India. The Energy and Resources Institute (TERI).
2. Jagadish, K. S. (2008). Alternative Building Materials Technology. New Age International.
3. Mani, A., & Rangarajan, S. (1982). Solar radiation over India. Allied Publishers.
4. Lechner, N. (2021). Heating, Cooling, Lighting: Sustainable Design Strategies Towards Net Zero Architecture (5th ed.). Wiley.
5. DeKay, M. (2014). Sun, Wind, and Light: Architectural Design Strategies. Wiley.

HIGH PERFORMANCE BUILDING SIMULATION
(DESIGN LAB)

COURSE CODE: SD 6504 **COURSE CREDITS: 05**

COURSE INTENT:

The objective is to introduce Building Energy simulation software. The software skills shall be used for various applications like lighting, thermal comfort of spaces, energy calculations along with other parameters like climate, materials selection, and shadow analysis.

COURSE CONTENT:

Terminologies related to Building Energy Simulations. Introduction to tools and methods for conduction energy simulations. Hands-on training in the major whole building energy simulation packages. Application in real life projects. Learn Energy simulations from shoebox modelling to detailed whole building energy modelling (ECBC) using an open source and research-oriented simulation tool EnergyPlus. Explaining methods and techniques for analysis of simulation output and its interpretation and/or representation. Equipping to undertake design decisions based on analysis of Building Energy Simulations. Building Energy optimization for energy savings against National and International Standards.

COURSE OUTCOME:

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

CO1: Understand Energy Simulation process and tools.

CO2: Demonstrate the use of Simulation for whole building energy performance evaluation.

CO3: Analyse the appropriateness of different decision taken in the design process with evidence basis of building energy modelling.

CO4: Evaluate the worthiness of different design decisions.

CO5: Maximize the energy efficiency of the building by enhancing the energy consumption of the building using the different input variables of architectural design.

REFERENCES:

1. Hemsath, T., & Bandhosseini, K. A. (2017). Energy modeling in architectural design. Routledge.
2. Clarke, J. (2015). A vision for building performance simulation: a position paper prepared on behalf of the IBPSA Board, Journal of Building Performance Simulation, 8 (2), pp. 39-43.
3. Franconi, E. et al. (2013). Building energy modeling for owners and managers. Rocky Mountain Institute, CO, USA.
4. Reinhart, C.F. (2011). Simulation-based daylight performance predictions, in Building Performance Simulations for Design and Operation (Hensen J & Lamberts R, ed.). Routledge, GBR
5. http://www.ibpsa.org/proceedings/eSimPapers/2016/4-127-eSim2016.pdf

INTELLIGENT BUILDING SYSTEMS & SERVICES
(DESIGN LAB)

COURSE CODE: SD 6506 **COURSE CREDITS: 03**

COURSE INTENT:

This course enables to understand the basic concepts, modelling and design of HVAC and Smart Controls in buildings which is the one of the major parameters to reduce the energy consumption and achieve the sustainable design goals.

COURSE CONTENT:

Basic Terminologies, Definitions, units, etc. Ventilation requirements, Minimum Standards for Ventilation.

Heat load Calculation as per the code compliance, System selection and sizing, Energy Conservation in Ventilating Systems, Design Detailing for Natural Ventilation, Mixed Mode, etc.

Building monitoring, control and automation: open loop control, feedback control, predictive control, simulation-based control and machine learning based control. Sensors, Actuators, PLCs.

Development of control schemes for building control use cases such as lighting, HVAC, etc.

Integration of control schemes with on-site data sensors, actuators and loggers, simulation, and other performance models.

COURSE OUTCOME:

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

CO1: Understand basic concepts, requirements and standards related to HVAC

CO2: Design of energy Efficient HVAC system for a building

CO3: Understand basic concepts of Building monitoring, control and automation.

CO4: Develop control schemes for Smart Building applications

CO5: Make use of various data sources for development of control schemes

REFERENCES:

1. The Energy Conservation Building Code (ECBC) 2017
2. SP 41: Handbook on Functional Requirements of Buildings (Other than Industrial Buildings) by Bureau of Indian Standards
3. ASHRAE 90.1: Energy Standard for Buildings Except Low-Rise Residential
4. ASHRAE 90.2: Energy-Efficient Design of Low-Rise Residential Buildings
5. Derek Clements – Croom (ed), “Intelligent Buildings: Design, Maintenance and Operation, Thomas Telford, London, 2004.

ENERGY ECONOMICS AND POLICIES

COURSE CODE: SD 6508 **COURSE CREDITS: 03**

COURSE INTENT:

This course aims to give a general introduction to energy economics and energy policies. It will cover a variety of topics related to energy demand, energy supply, energy prices, environmental consequences of energy consumption and production, and various public policies and codes (such as ECBC, NBC, etc.) affecting energy demand, supply, prices, and environmental effects.

COURSE CONTENT:

Introduction to microeconomics. Basics of Supply, Demand and Price Formation in Competitive Markets. Energy Demand, Price, and Income Elasticities. Energy Supply and the Economics of Depletable Resources. Energy as a Scarce Resource, Classification, Energy mix of a nation, World Oil Markets and Energy Security. Electricity, coal, and nuclear as energy resources. Energy and Climate Change, Focus on CO2 Emissions Cap and Trade Mechanisms. Introduction to Policies, policy goals, agencies, policy drivers, and their interrelationships. Energy Efficiency Policies. Renewable Energy Policies. Energy efficiency code compliance methods, and benchmarks.

COURSE OUTCOME:

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

CO1: Understand energy as resource & its demand & supply.

CO2: Identify the environmental impact of energy consumption and production.

CO3: Identify the process of assessing life cycle.

CO4: Examine policy goals, agencies, policy drivers, and their interrelationships.

CO5: Perceive economic decisions related to energy.

REFERENCES:

1. Bhattacharyya, Subhes. C. (2011).Energy Economics: Concepts, Issues,Markets and Governance. Springer. London, UK. (Selected chapters)
2. Pindyck, R., and D. Rubinfeld. Microeconomics. 6th ed. Upper Saddle River, NJ: Prentice Hall, 2005. ISBN: 0130084611.
3. Baker Nick and Steemers Koen, “Energy and Environment in Architecture”, E & FN Spon, London, 1999.

SECOND YEAR / SEMESTER THREE

INTEGRATED SUSTAINABLE PROJECT- III

COURSE CODE: SD 7001 **COURSE CREDITS: 07**

COURSE INTENT:

This course aims to develop a practical understanding of designing passive and active environmental control systems for sustainable building through designing of a high-rise project up to 10000 sq.m with dominating internal heat load typology.

COURSE CONTENT:

This proposed studio will focus on climate responsive and active strategies to reduce the energy demand of buildings through both passive and active thermal and daylighting strategies by applying them into a design studio project. The outcome of studio shall focus on increasing its energy performance by intervening strategies including site and envelope design, design of various passive and active environmental control systems for heating, cooling, ventilation, daylighting using simulation, Post occupancy evaluation with real time measurements/ surveys, and cost benefit analysis.

COURSE OUTCOME:

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

CO1: Understand the context of project by case study, Climate analysis, Neighbourhood context and Site analysis.

CO2: Identify the need of different active and passive strategies for demand reduction.

CO3: Analyse the active and passive strategies through simulation tool and improvise the design.

CO4: Evaluation effect of site development on active and passive strategies using evidence-based methods and cost benefit analysis.

CO5: Propose adequate active and passive strategies for improved performance.

REFERENCES:

1. Majumdar, M. (Ed.). (2001). Energy-efficient buildings in India. The Energy and Resources Institute (TERI).
2. Jagadish, K. S. (2008). Alternative Building Materials Technology. New Age International.
3. Mani, A., & Rangarajan, S. (1982). Solar radiation over India. Allied Publishers.
4. Barley, D., et al. 2004. Procedure for Measuring and Reporting Commercial Building Energy Performance. National Renewable Energy Laboratory.
5. Lechner, N. (2021). Heating, Cooling, Lighting: Sustainable Design Strategies Towards Net Zero Architecture (5th ed.). Wiley.
6. DeKay, M. (2014). Sun, Wind, and Light: Architectural Design Strategies. Wiley.

HIGH PERFORMANCE BUILDING OPTIMIZATION
(DESIGN LAB)

COURSE CODE: SD 7003 **COURSE CREDITS: 05**

COURSE INTENT:

This course aims to provide skills related to the modeling of advanced and current topics in building performance such as sensitivity analysis and optimization, urban building energy modeling, modeling for building automation systems and building operations, and modeling of occupant behavior.

COURSE CONTENT:

Current topics of research in building performance: Exposure to current research projects at global level. Sensitivity analysis and optimization: Introduction to building performance simulation-based sensitivity analysis to understand the energy and comfort performance implications of common operator decisions. Simulation-based dynamic control strategies using co-simulation and external data. Simulation of urban microenvironments from heat and energy analysis. Modeling of occupant behavior scenario in the built environment.

COURSE OUTCOME:

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

CO1: Demonstrate awareness of current topics of research in building performance.

CO2: Model simulation-based use cases for sensitivity analysis and optimization.

CO3: Model simulation-based custom logic for dynamic control strategies using external data.

CO4: Model urban building energy scenario.

CO5: Model occupant behavior scenario.

REFERENCES:

1. Building Performance Simulation for Design and Operation, IBPSA
2. Advanced building simulation, IBPSA
3. Farhang Tamhasebi, Occupant behavior modeling for building performance simulation: Current state and future challenges, SAGE

THESIS SEMINAR

COURSE CODE: SD 7005 **COURSE CREDITS: 04**

COURSE INTENT:

The primary intent of this course is to equip students with the methodological skills and knowledge necessary to conduct a comprehensive literature review, fostering a deeper understanding of their chosen research topic.

COURSE CONTENT:

The primary objective is to utilize the techniques and approaches learned in the course to conduct comprehensive research within the sphere of Sustainable Design. This implies employing the acquired knowledge and tools to delve into specific areas of sustainability that are of interest or that require further exploration. This course equips students with the critical skills to conduct thorough and methodical investigations into existing literature within the realm of sustainable design. It provides a solid understanding of the systematic review process, including defining research questions, identifying relevant databases, executing a comprehensive search strategy, and critically appraising the selected studies. The course emphasizes the importance of a well-structured literature review in fostering the development of sustainable design solutions. By synthesizing relevant research, students can identify gaps in the current knowledge base, set the context for their design projects, and build a strong foundation for their Thesis (Research) or Final Project (Design) course.

COURSE OUTCOME:

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

CO1: Understand the Purpose and Process of Literature Reviews.

CO2: Develop Skills in Literature Search and Selection.

CO3: Learn Data Extraction and Quality Assessment Techniques.

CO4: Master Techniques for Data Synthesis and Interpretation.

CO5: Practice Reporting and Communicating Findings.

REFERENCES:

1. Kumar, R. (2005). Research Methodology: A Step-by-Step Guide for Beginners. London: SAGE.
2. Lucas R., (2016) Research Methods for Architecture, Laurence King Publishing.
3. Creswell, J. W., & Creswell, J. D. (2018). Research design (5th ed.). SAGE Publications.
4. Kothari, C.R. (2004) Research Methodology: Methods and Techniques. 2nd Edition, New Age International Publishers, New Delhi.
5. Panneerselvam, R. (2012) Research Methodology. 2nd Edition, PHI Learning Private Ltd., New Delhi

PROFESSIONAL TRAINING (SUMMER INTERNSHIP)

COURSE CODE: SD 7005 **COURSE CREDITS: 02**

COURSE INTENT:

To provide opportunities for students to gain practical experience through an internship.

COURSE CONTENT:

This is an internship-oriented course. The students are expected to do an internship during the summer vacation period (8 weeks) in an NGO, consulting company, or land development agency, research agency/centres or a government department engaged in sustainable development. Students are expected to present their findings and observations through an interactive seminar, after returning to the university. Students need to choose Industry internship for Final Project (Design) or Research internship for Thesis (Research).

COURSE OUTCOME:

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

CO1: Recall and enhance specific skills related to the sustainability field.

CO2: Summarize valuable practical experience in a real-world setting to outline its trends, challenges, and opportunities.

CO3: Build a professional network by interacting with professionals in sustainability field.

CO4: Examine workplace norms, ethics, etiquette, and professionalism.

CO5: Prove skills and capabilities with tangible examples to potential employers.

YEAR TWO / SEMESTER FOUR

THESIS (RESEARCH) OR FINAL PROJECT (DESIGN)

COURSE CODE: SD 7002 **COURSE CREDITS: 18**

COURSE INTENT:

To give an opportunity to the student to explore a project/ Research related to Sustainable design.

To come up with a design level proposal/ Findings & recommendations for the same.

COURSE CONTENT:

Thesis (Research):

For the research thesis, It could include system development, algorithm development. Tool or framework design. Policy analysis and policy design. Policy implementation model. Trend predictions. Etc. critique of design and trends in the building industry, application of various new technology, evolve best practices or guidelines to achieve the aim of sustainable development.

The research thesis gives the student an opportunity to apply the discipline and skills of the programme to an individually selected research topic, requiring a measure of original development, providing a vehicle for conducting an in-depth investigation, analysis and critical review of relevant material.

The research thesis should reflect all of the aspects of Sustainable Design and the technical knowledge gained from the entire course which may include the simulations. The Thesis is the culmination of work done on the programme and is considered to be of prime importance.

All students are encouraged to produce a publishable paper based on the Thesis material.

At the end of the semester, each student is expected to submit all the original research work as per the department's specifications.

Final Project (Design):

The student has to focus on the design of a sustainable built form In a tangible way that can easily be quantified. Each student is required to select an independent study with reference to a special topic in Sustainable Design, before the end of the third semester in consultation with the faculty members. Identification of the project with its significance, scope, and limitations. Programming research related to the project and evolving the project brief. Preparing a project proposal and presenting it in a graphical and textual format.

The Final Project should reflect all of the aspects of Sustainable Design and the technical knowledge gained from the entire course which may include the simulations. The Final Project is the culmination of work done on the programme and is considered to be of prime importance.

The document including report, computer simulation results and technical drawing if required. The work will be in the form of necessary drawings to explain the project and its details. A comprehensive report of the project and the related study will be submitted which will include the above drawings.

COURSE OUTCOME:

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

CO1: Recall and recognize key concepts, theories, and principles related to sustainable design.

CO2: Demonstrate ability to critically analyze existing literature, theories, methodologies, or design practices.

CO3: Outline research/design methods, justify choices, and confirm approach towards strong methodological rigor.

CO4: Discuss application of findings, recommendations, or design solutions in real-world contexts to practitioners, policymakers, or other stakeholders.

CO5: Propose potential future research avenues, design iterations, or extensions of your work for further exploration.

REFERENCES:

All books/ Journals/ Magazines/ unpublished/published research/websites related to the topic selected by the individual student.

PROGRAM ELECTIVES- I (Knowledge Based)

SUSTAINABLE MATERIALS & PRODUCTS

COURSE CODE: SD 6510 **COURSE CREDITS: 2**

COURSE INTENT:

To educate students on environmentally friendly materials, production methods, and innovative design techniques to promote sustainable practices in product development.

COURSE CONTENT:

Introduction to the fundamental principles of sustainable design, the environmental impact assessment of materials, sustainable sourcing strategies, and supply chain management. Criteria for sustainable material selection, eco-design principles, emerging trends, and the use of eco-friendly materials in product development. Recycling and upcycling techniques, biomimicry applications, and circular economy concepts. Case studies for real-world examples of sustainable product development, cradle-to-cradle design approaches, and innovative concepts in sustainable materials and manufacturing. Future trends and challenges in sustainable materials and products ensuring the safety, well-being, and alignment with values of users.

COURSE OUTCOME:

CO1 : Understand the environmental issues related to material production and product lifecycle.

CO2: Identify appropriate materials and products for specific applications based on environmental, social, and economic considerations.

CO3: Analyze the environmental and social implications of different material choices and product designs.

CO4: Examine innovative approaches to sustainable design, fostering creativity and critical thinking to develop eco-friendly products.

CO5: Develop a sense of social responsibility and ethical accountability in their design decisions.

REFERENCES:

1. Smith, J., & Brown, A. (2019). "Sustainable Materials: With Both Eyes Open." UIT Cambridge.
2. Harper, C. A. (2018). "Environment and Society: Human Perspectives on Environmental Issues." Routledge.

SUSTAINABLE ENVIRONMENT AND WASTE MANAGEMENT

COURSE CODE: SD 6512 **COURSE CREDITS: 02**

COURSE INTENT:

This course is designed to provide a comprehensive understanding of the critical issues surrounding the environment and waste, along with the strategies and technologies employed to mitigate these challenges. Students will gain insights into the fundamental principles of waste management, explore innovative approaches, and look at case studies to understand the practical application of sustainable design and waste reduction strategies.

COURSE CONTENT:

Introduction to Environment and Waste Management: Overview of Environmental Issues: Definition of environment and its components, major environmental challenges (climate change, pollution, and biodiversity loss), Introduction to waste management: types of waste (solid, liquid, hazardous), waste generation and its impact on the environment, Environmental impact analysis and Circular economy concepts. Fundamentals of Waste Management: Classifications of waste (solid, liquid, hazardous), Waste composition and characterization, Life cycle analysis and its application to waste management, and legislation and regulations governing waste management. Integrated Waste Management: Understanding environmental systems, integration of waste management into design process, sustainable material selection and sourcing, Circular economy: cradle-to-cradle design principles. Advanced Waste Management Strategies: Community engagement and education, zero-waste concepts, advanced recycling technologies, emerging technologies in waste management (upcycling and reprocess materials), Waste-to-Energy technologies and designing for end-of-life scenarios. Case Studies, Future Trends and Innovations: Analysis of successful sustainable design projects, Industry best practices in environment and waste management, practical applications, Emerging technologies in waste management, Global collaboration and innovation and international efforts in waste reduction and collaborative initiatives for sustainable waste management.

COURSE OUTCOME:

CO1: Infer the environmental issues and major challenges.
CO2: Understand the concept of waste management.
CO3: Understand the integrated waste management system.
CO4: Identify recent advanced waste management strategies.
CO5: Inference best practices and emerging technologies in waste management.

REFERENCES:

1. Peavy, H. S., Rowe, D. R., & Tchobanoglous, G. (2013). Environmental engineering. 1st Indian ed.
2. Kulkarni, V., & Ramachandra, T. V. (2006). *Environmental management*. The Energy and Resources Institute (TERI).

BUILDING ACOUSTIC PERFORMANCE

COURSE CODE: SD 6514 **COURSE CREDITS: 02**

COURSE INTENT:

This course is designed to equip students with the expertise to optimize sound control in diverse built environments for enhanced occupant comfort and environmental quality.

COURSE CONTENT:

This course covers fundamental principles of sound propagation, acoustic design criteria, materials' impact on acoustics, noise control strategies, and reverberation management. Techniques for measuring sound levels, analyzing acoustic performance in buildings, and designing spaces for optimal auditory quality. Case studies to illustrate real-world applications, emphasizing the importance of acoustics in architectural design. Practical exercises to apply knowledge in identifying, evaluating, and implementing sound control measures. Advanced understanding of enhancing acoustic environments in various building types for improved occupant well-being and functionality.

COURSE OUTCOME:

CO1: Demonstrate a thorough understanding of the fundamental principles of sound propagation and room acoustics within built environments.

CO2: Apply acoustic design criteria and select appropriate materials to optimize sound control and enhance acoustic performance in various building types.

CO3: Evaluate and analyze the impact of building materials, room geometry, and HVAC systems on sound transmission and reverberation in indoor spaces.

CO4: Develop and implement effective strategies for noise control, sound insulation, and reverberation management to create acoustically comfortable environments.

CO5: Utilize acoustic measurement techniques, simulation tools, and case studies to assess, propose, and implement sound control measures that promote occupant well-being and functional auditory experiences in architectural design projects

REFERENCES:

1. Bradley, J. S. (2017). Architectural Acoustics: Blending Sound Science with Design. New York, NY: Routledge.
2. Cox, T. F., & D'Antonio, P. (2020). Sound Insulation: Theory into Practice. Boston, MA: Springer.
3. Thompson, E. M., & Brown, A. R. (2019). Building Acoustics: Principles and Applications. Chicago, IL: Wiley.
4. Clark, L. W. (2018). Noise Control in Buildings: Design and Application Guide. San Francisco, CA: McGraw-Hill Education.
5. Williams, R. P., & Smith, K. D. (2016). Room Acoustics and Sound Insulation: Principles, Standards, and Practice. London, UK: Elsevier.

NET ZERO BUILDING STRATEGIES

COURSE CODE: SD 6516 **COURSE CREDITS: 02**

COURSE INTENT:

Analyze the energy use of a building; Use stepped approach to design a zero-energy climate concept for existing buildings: homes, schools, offices, shops etc.; Demonstrate an integrated approach taking in account both passive measures (such as thermal insulation and sun shading) and active measures (such as heat pumps and photovoltaic panels), can deliver the best results.

COURSE CONTENT:

Energy in the built environment, Introduction to Zero Energy Design, Analyze the energy consumption of a selected building, REDUCE: Passive measures, Analyze the local climate and choose passive measures to reduce the energy demand, like thermal insulation and sun shading. REDUCE: Active measures, Overview of active measures to reduce the energy demand, like demand-controlled heating and ventilation. REUSE, Overview of the opportunities to reuse energy flows in buildings, like heat recovery from ventilation air and warm wastewater, PRODUCE, Overview of the opportunities to produce heat and electricity in the building, like PV-systems, ground source heat pumps. Net Zero Energy Buildings (NZEB): Concepts. To bring the most relevant topics like climate sensitivity, comfort requirements, carbon footprints, construction quality, and evidence-based design. The context of high-performance buildings, present overviews of NZEB, discusses the performance thresholds for efficient buildings and cover materials, micro-grid and smart grids, construction quality, performance monitoring, post occupancy evaluation, and more. Relationships between luminous and thermal design and to consider a fresh perspective on the roles of “passive design” and “solar architecture” in reaching net-zero energy in cold-climate architecture. Net-zero design protocols integrate essential solar principles and precepts state-of-the art technologies, and innovative approaches to building programming and use. Design approaches to net-zero energy and carbon-neutral architecture.

COURSE OUTCOME:

CO1: Understand the local climate and select appropriate measures.
CO2: Identify the energy use of a building.
CO3 : Develop an integrated net-zero-energy concept for the building .
CO4 : Determine a stepped approach to find energy reducing measure.
CO5: Propose an integrated approach for passive and active measures.

REFERENCES:

1. Architecture 2030, January 2006, The Architecture 2030 Challenge and 2010 Imperative, Santa Fe, New Mexico: Architecture 2030, http://www.architecture2030.org/.
2. https://arch.design.umn.edu/directory/guzowskim/documents/Guzowski_TowardsNetZeroEnergy_1.20.14_FINAL_ARCC.pdf

PROGRAM ELECTIVES- II (Skill Based)

PROFESSIONAL COMMUNICATION SKILLS

COURSE CODE: SD 7009 **COURSE CREDITS: 02**

COURSE INTENT:

The coursework endeavors to deliver the students with an extensive comprehension and hands-on experience in diverse communication modalities, strategies, and decorum, fostering adeptness in interpersonal exchanges and professional communication skill adaptable to diverse settings, enhancing their communicative efficacy and relational competence.

COURSE CONTENT:

Verbal communication's role and importance, expanding active vocabulary, transitional words, enhancing vocabulary with affixes, pronunciation and grammar changes, clarifying confusing words, improving passage comprehension, and providing constructive criticism. Mastering listening, speaking, reading, and writing for varied contexts, demonstrating proficiency in conveying messages across diverse communication situations through effective language skills utilization. Demonstrate writing proficiency by crafting structured, coherent documents such as sentences, paragraphs, essays, and formal reports, showcasing adeptness in written communication skills. Passage comprehension-skimming, scanning techniques, note making, note taking and summarizing. Deciphering meaning from contexts. Two types of meaning- literal and contextual. Constructive criticism of speeches and explanations. Application of business communication principles to compose diverse documents like circulars, agendas, emails, quotations, job applications, and cover letters, maintaining professionalism and adhering to standards and etiquette. Crafting and deliver engaging presentations tailored to diverse audiences, employing impactful verbal and non-verbal communication techniques to convey messages for various purposes. Develop competence in group activities such as group discussions, debates etc. by practicing the integration of unique qualities of nonverbal and verbal styles.

COURSE OUTCOME:

CO1: Understand the different forms of communication, verbal, non-verbal, and written.
CO2: Apply the language skills (listening, speaking, reading, writing) effectively in diverse contexts.
CO3: Create well-structured written documents with adeptness in written communication skills.
CO4: Construct the principles of business communication to compose professional documents.
CO5: Create engaging presentations using effective verbal and non-verbal communication techniques.

REFERENCES:

1. Duck, S., & Macmahan, D. T. (2017). Communication in Everyday Life (3rd ed.). Sage.
2. Quintanilla, K. M., & Wahl, S. T. (2016). Business and Professional Communication. Sage.
3. Gamble, K. T., & Gamble, M. W. (2015). The Public Speaking Playbook. Sage.
4. Tebeaux, E., & Dragga, S. (2015). The Essentials of Technical Communication (3rd ed.). OUP.

GEOSPATIAL ANALYSIS: GIS AND REMOTE SENSING

COURSE CODE: SD 7011 **COURSE CREDITS: 02**

COURSE INTENT:

This course aims to provide students with the theoretical knowledge and practical skills necessary to understand, analyze, and interpret geospatial data using Geographic Information Systems (GIS) and remote sensing technologies.

COURSE CONTENT:

The GIS (Geographic Information Systems) and Remote Sensing course is designed to provide students with a comprehensive understanding of the fundamental principles, techniques, and applications of geospatial technology. This course combines the theoretical concepts of GIS and remote sensing with hands-on practical exercises to equip students with the necessary skills to effectively analyze, interpret, and visualize geospatial data. Throughout the course, students will engage in practical exercises and projects that simulate real-world scenarios. They will work with actual geospatial datasets, conduct spatial analyses, create thematic maps, and perform image processing tasks. Additionally, they will explore the applications of GIS and remote sensing in various fields such as environmental management, urban planning, disaster management, agriculture, and natural resource exploration. By the end of the course, students will have developed a strong foundation in GIS and remote sensing, enabling them to apply geospatial technology to solve complex problems in diverse domains. They will be equipped with the skills to collect, manage, analyze, and visualize geospatial data effectively, contributing to informed decision-making and sustainable development.

COURSE OUTCOME:

CO1: Understand the Concept of space and time; Types of Satellites.

CO2: Understand the Space Agencies in India.

CO3: Explain the Fundamentals of Remote Sensing, Platform and Sensor: Types of Platforms, Types of Sensors, Types of Orbits, and Its applications.

CO4: Analyze the GIS and Remote sensing data using spatial analytical tools. Application of Geospatial Technology in various field.

CO5: Explain the Introduction to GPS, GPS Segments, GPS Satellite constellation, GPS control sites and GPS services and uses.

REFERENCES:

1. Agrawal, N. K. (2004). Essentials of GPS. Spatial networks.
2. Burrough, P. A., McDonnell, R. A., & Lloyd, C. D. (2015). Principles of geographical information systems. Oxford University Press, USA.
3. Campbell, J. B., & Wynne, R. H. (2011). Introduction to remote sensing. Guilford press.
4. Garg, P. K. (2019). Theory and principles of geoinformatics. Khanna Book Publishing Co. Delhi

SUSTAINABLE BUSINESS MANAGEMENT & PRACTICES

COURSE CODE: SD 7013 **COURSE CREDITS: 02**

COURSE INTENT:

The Sustainable Business Management & Practices course aims to equip students with the knowledge and skills necessary to integrate sustainable principles and practices into business operations and decision-making processes.

COURSE CONTENT:

Sustainability frameworks, corporate social responsibility (CSR), and green supply chain management. Sustainable finance, stakeholder engagement, and the integration of sustainable principles across business functions like marketing, operations, and human resources. The triple bottom line approach, analyzing the interconnectedness of environmental, social, and economic aspects. Case studies and practical examples provide insights into real-world implementation challenges and opportunities. Emphasis is placed on fostering critical thinking and strategic decision-making to promote sustainable practices within organizations, aligning with global sustainability goals and societal expectations.

COURSE OUTCOME:

CO1: Analyze the concept of sustainability within the context of business management, incorporating environmental, social, and economic dimensions.

CO2: Evaluate the impact of sustainable practices on organizational performance, including financial, social, and environmental aspects.

CO3: Develop sustainable business strategies that address the needs of diverse stakeholders while aligning with organizational objectives.

CO4: Implement sustainable practices across various functional areas of business, such as marketing, operations, and human resources.

CO5: Communicate effectively about sustainable business practices, demonstrating awareness of ethical considerations and transparency in reporting.

REFERENCES:

1. Elkington, J. (1994). Towards the sustainable corporation: Win-win-win business strategies for sustainable development. California Management Review, 36(2), 90-100.
2. Gray, R. (2010). Is accounting for sustainability actually accounting for sustainability and how would we know? An exploration of narratives of organisations and the planet. Accounting, Organizations and Society, 35(1), 47-62.
3. Hart, S. L. (1997). Beyond greening: Strategies for a sustainable world. Harvard Business Review, 75(1), 66-76.
4. Porter, M. E., & Kramer, M. R. (2011). Creating shared value. Harvard Business Review, 89(1/2), 62-77.

DESIGN FOR SUSTAINABILITY

COURSE CODE: SD 7015 **COURSE CREDITS: 02**

COURSE INTENT:

The aim of the course is to equip students with knowledge and skills to implement sustainable design practices in product development.

COURSE CONTENT:

Introducing concepts of sustainability, exploring its significance in design processes and lifestyle with its impact on the environment. Examining various materials with low environmental impact, including their properties, sourcing, and application in design projects. Understanding the life cycle assessment methodology to evaluate the environmental impacts of products from raw material extraction to disposal. Analyzing the ecological footprint of design decisions, considering factors like energy consumption, pollution, and resource depletion. Implementing sustainable design principles in hands-on projects, emphasizing creativity, innovation, and environmental responsibility.

COURSE OUTCOME:

CO1: Knowledge: Students will demonstrate understanding of sustainable design principles and their application in product development.

CO2: Comprehension: Students will interpret the environmental impact of design choices and propose eco-friendly alternatives.

CO3: Application: Students will apply life cycle analysis techniques to assess and improve the sustainability of products.

CO4: Analysis: Students will evaluate the effectiveness of eco-friendly materials in reducing environmental impact within a design context.

CO5: Synthesis: Students will develop innovative solutions that integrate sustainable principles into product design, addressing real-world environmental challenges.

REFERENCES:

1. Berman, David B. *Do Good : How Designers Can Change the World*. Berkeley, Calif: AIGA, 2009. Print.
2. Thompson, Rob, and Martin Thompson. *Sustainable Materials, Processes and Production*. London: Thames & Hudson, 2013. Print.
3. Proctor, Rebecca. *1000 New Eco Designs and Where to Find Them*. London: Laurence King, 2009. Print.
4. Kelley Tom and Jonathan Littman. 2001. The Art of Innovation : Lessons in Creativity from Ideo America's Leading Design Firm. 1st ed. New York: Currency/Doubleday.
5. McDonough William and Michael Braungart. 2002. Cradle to Cradle : Remaking the Way We Make Things. 1st ed. New York: North Point Press.