Course title: Building Energy Management and Green Building			
Course code: DSE 113	**No. of credits:** 3	L-T-P:39-6-0	**Learning hours:** 45
Pre-requisite course code and title (if any): N.A.			
Department: Sustainable Engineering			
Course coordinator: Dr. Ramkishore Singh		**Course instructor(s):** Dr. Ramkishore Singh	
Contact details: ramkishore.singh@terisas.ac.in			
Course type: Core		**Course offered in:** Semester 2	

Course description:

This course has been designed to make the students versed about building energy consumption nationally and globally, its impact on the climate change and vice-versa, passive and active energy reducing strategies and systems, building energy management smart solutions. Further, students will learn about Energy conservation building codes and its recommendation for improving energy efficiency of the buildings, Green Buildings rating tools and procedure for developing green buildings

Course objectives:

1. To get students learn and remember about the energy consumption in different process in the buildings.
2. To learn, understand the passive and active strategies and system as well as be able to apply for lowering building energy use in buildings.
3. To evaluate the impact of embodied energy of construction materials on the overall building energy consumption and indoor thermal comfort.
4. To learn and understand the procedure for applying to quantify energy savings in buildings.
5. To understand green building rating tools and to implement strategies for creating/achieving the green building status.

Module	Topic	L	T	P
1.	**Introduction to Energy Use in Buildings** o Role of buildings in global and national energy use o Demand for different energy services in buildings and their drivers o Indirect energy use from activities in buildings: Using life cycle approach o Impact of a changing climate on building energy service demand o Specific sustainability challenges related to energy services in buildings	4		
2.	**Climate and Solar radiation** o Factors affecting climate o Climatic zones and their characteristics o Sun-earth geometric relationship o Angle of incidence o Sun path diagram o Solar radiation on different surfaces of buildings o Solair temperature	4		
3.	**Human comfort** o Human body and environmental conditions o Parameters of thermal comfort o Heat exchange between human body and environment o Thermal comfort indices o Visual comfort: Basics of light; Visual comfort factors o Acoustic comfort: Principles of sound; Effect of noise; sound transmission	3		
4.	**Introduction to Building Physics** o Purpose of the buildings o Basic principles of heat transfer o Design conditions for heating and cooling in buildings o Heat transfers through walls, roof and fenestration o Heat loss from basement walls, floors and crawl spaces o Infiltration and ventilation heat loads	6	4	

	○ Energy and Thermal performance of the buildings: Energy and heat exchange in buildings ○ Estimation of indoor temperature and air conditioning load ○ Visual performance of the buildings			
5.	**Reducing Energy Use in Building: Passive strategies, systems and construction materials** ○ Building Shape, Form and Orientation ○ Improving skin insulation: Using Degree days and balance point temperature ○ Improving ventilation heat transfer ○ Internal and external shading devices ○ Ventilation, Evaporative cooling ○ Earth–air tunnel ○ Sky-therm system ○ Solar chimney-based hybrid system ○ Desiccant Cooling and Dehumidification ○ Natural ventilation ○ Direct evaporative cooling using drip-type (desert) coolers ○ Efficient and dynamic fenestrations ○ Low embodied energy materials	6		
6.	**Reduction in Energy Use in Building: Active systems** ○ District Heating and Cooling ○ Improving heating and cooling systems' efficiency ○ Energy efficient appliances ○ Energy efficient lighting ○ Smart energy management systems	4	2	
7.	**Quantification of energy savings** ○ Energy models ○ Embodied energy of buildings ○ Energy levelling for appliances ○ Testing the building for energy saving opportunities ○ Building energy modelling ○ Smart metering	6		
8.	**Building energy codes and green building ratings** ○ Energy conservation building codes and recommendation for existing and new buildings ○ Energy efficient, net zero, green and sustainable buildings ○ Green building rating systems: LEED, GRIHA, BREEAM etc. ○ Role of green buildings on the sustainability of the society	6		
Total		39	6	

Evaluation criteria

Assignment1: 10% (after Module 1-4)
Assignment 2: 10% (after Modules 5-7)
Minor test 1: 15% (after Module 3)
Minor test 2: 15% (after Module 6)
Major test: 50% (after all module)

Learning outcomes:

This course inculcates the skills that shall make the students to:

1. be able to understand, analyse the buildings energy consumption and impact on climate change.
2. learn and remember about the factors that affect human comforts and ensuring indoor comfort conditions.
3. be able to evaluate energy and heat transfer from different components of buildings.
4. be able to understand and create/implement the passive and active techniques for reducing energy consumption in buildings.

5. be able to evaluate and quantify the energy saving potential in buildings.
6. learn recommendations and mandatory requirement for energy conservation through energy conservation codes and their implementation
7. learn about green rating tools and their implementation procedure and creating green buildings.

Pedagogical approach

A combination of class-room interactions, tutorials, practical and assignments.

Materials

Recommended readings

Text Books

1. *Bob Everett and Horace Herring and team. (2007). Energy saving in buildings, The Open University, UK*
2. *Chapter 16: HEATING AND COOLING OF BUILDINGS, Yunus A. Cengil and Afshin Ghajar. Heat and Mass Transfer: Fundamentals and Applications. 6th Edition, McGraw-Hill*
3. *Fergus Nicol, Hom Bahadur Rijal, Susan Roaf. Handbook of Resilient Thermal Comfort. Routledge; 1st edition (29 November 2024)*
4. *Global Energy Assessment Writing Team. Global Energy Assessment: Toward a Sustainable Future. Cambridge University Press; 2012*
5. *Koenigsberger, Ingersoll, Mayhew and Szokolay. (1975). Manual of tropical housing and building. Part 1: Climate design, Orient Longman Limited.*

Reference Books

1. Sustainability Through Energy Efficient Buildings. (2018). Edited by Amritanshu Shukla and Atul Sharma. CRC Press
2. Wen hong, Madelaine Steller Chiang, Ruth A. Shapiro, Mark L. Clifford. (2007). Building Energy Efficiency, The Asia Business Council
3. Pieter de Wilde.2018. Building Performance. Analysis. John Wiley & Sons Ltd.
4. Ursula Eicker, 2009, Low Energy Cooling for Sustainable Buildings, Willey
5. Minke, G., 2006. Building with Earth: design & technology of a sustainable architecture, SpringerLink
6. Givoni, B., 1998. Climatic Considerations in Buildings and Urban Design, John Wiley & Sons, Canada
7. N. K. Bansal, Gerd Hauser, Gernot Minke, 1994. Passive building design: a handbook of natural climatic control, Elsevier Science
8. B.V. Krishnan, A., Baker, N., Yannas, S., Szokolay, S., (Eds) 2001. Climate Responsive Architecture-A Design Handbook for Energy Efficient Buildings, Tata McGraw-Hill, New Delhi
9. Givoni, B., 1994. Passive and Low Energy Cooling of Buildings, John Wiley &Sons Inc., New York
10. Santamouris, M., 1996. Passive Cooling of Buildings, James & James (Science Publishers) Ltd., London
11. Karlen, M and Benya, J., 2004. Lighting Design Basics, John Wiley &Sons Inc., New York
12. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): Fundamentals, Equipment Indian Society of Heating, Refrigerating and Air-Conditioning Engineers (ISHRAE) Standards
13. Richard R Janis and William K Y Tao, 2008. Mechanical and Electrical Systems in Buildings, Prentice Hall
14. Vedavarz, A., Kumar, S. and Hussain, Md., 2007. HVAC: Heating, Ventilation and Air- Conditioning Handbook for design & Implementation, Industrial Press, New York
15. Jan F. Kreider, Peter S. Curtiss and Ari Rabl, 2010. Heating and Cooling of Buildings- Design for efficiency, revised second edition, CRC Press, USA
16. BEE, 2007. Energy Conservation Building Code http://www.usgbc.org/,
17. United States Green Building Council, USA http://www.igbc.in ,Indian Green Building Council, LEED India http://www.grihaindia.org/
18. BREEAM. https://breeam.com/
19. GRIHA Website, India TERI, 2004. Sustainable Building Design Manual, Vols 1 & 2.
20. Our World in Data**. https://ourworldindata.org/renewable-energy**
21. https://ibpsa.org/publications/
22. https://www.youtube.com/@IBPSAUniversity

Journals

- Journal of Building Performance Simulation
- Energy and Buildings
- Building and Environment
- Sustainable Cities and Society
- Applied Energy

Additional information (if any): NA

Student responsibilities:

Attendance, feedback, discipline: as per university rules

Course Reviewers

1. Prof. Athanasios "Thanos" Tzempelikos
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   Purdue University, USA

2. Prof. Dharam Buddhi
   Vice Chancellor, Uttaranchal University, Dehradun India
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3. Prof. Pieter de Wilde
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