

TEE-821 Advanced Thermal Energy Storage Systems Credit Hours: 03

Objectives

1. The objectives of this Advanced Thermal Energy Storage Systems course are:
 - a. To understand the fundamentals for the sensible and especially latent heat thermal energy systems
 - b. To analyses the governing physical principles with some simplified mathematical models
 - c. To discuss the main components of such systems, in detail
 - d. To develop new thermal energy storage (TES) systems
 - e. To apply TES into thermal system
 - f. To enable students to identify the optimal solutions to any thermal energy storage application, whether in the electrical, heat or transport sector.

Outcomes

2. By the end of this course students will be able to:
 - a. Recall the basic theory behind energy storage systems
 - b. Identify and explain the working principles of commercially-available thermal energy storage systems
 - c. Identify and explain the relative costs and sustainability of each technology
 - d. Evaluate the advantages and disadvantages of different thermal energy storage systems applied in a practical situation and compare the engineering problems in the real world
 - e. Describe sensible heat storage systems used for diurnal and inter-seasonal thermal energy storage
 - f. Evaluate the potential of phase change materials and chemical reaction systems for thermal energy storage
 - g. Compare the practicality of energy storage systems given the available resources within the local context
 - h. Evaluate the potential of energy storage in the local context from given case studies
- f. Contents with suggested contact hours

No.	Topics	Book	Contact
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			Hours
a.	Introduction to Energy Storage Systems <ul style="list-style-type: none"> • Fundamental Properties and Quantities • General Aspects of Thermodynamics and Heat Transfer • Energy Demand • Energy Storage • Energy Storage Methods • Comparison of ES Technologies 		4
b.	Thermal Energy Storage and Environmental Impact <ul style="list-style-type: none"> • Energy and the Environment • Major Environmental Problems • Environmental Impact and TES Systems and Applications • Potential Solutions to Environmental Problems • Sustainable Development • Illustrative Examples and Case Studies 		5
c.	Thermal Energy Storage (TES) Methods <ul style="list-style-type: none"> • Thermal Energy • Thermal Energy Storage • Solar Energy and TES • TES Methods • Sensible TES • Latent TES • Cold Thermal Energy Storage (CTES) • Seasonal TES 		6
d.	Thermal Energy Storage and Energy Savings <ul style="list-style-type: none"> • TES and Energy Savings • Additional Energy Savings Considerations for TES • Energy Conservation with TES: Planning and Implementation 		6

	<ul style="list-style-type: none"> • Some Limitations on Increased Efficiency • Energy Savings for Cold TES 		
e.	Energy and Exergy Analyses of Thermal Energy Storage Systems <ul style="list-style-type: none"> • Theory: Energy and Exergy Analyses • Thermodynamic Considerations in TES Evaluation • Exergy Evaluation of a Closed TES System • Exergy Evaluation of an Open TES System • Exergy Analysis of Thermally Stratified Storages • Energy and Exergy Analyses of Cold TES Systems • Exergy Analysis of Solar Ponds 		10
f.	Thermal Energy Storage Case Studies and Applications <ul style="list-style-type: none"> • Ice CTES Case Studies • Ice-Slurry CTES Case Studies • Chilled Water CTES Case Studies • PCM-Based CTES Case Studies • PCM-Based Latent TES for Heating Case Studies • Sensible TES Case Studies • TES Systems for Heating and Cooling in Residential Buildings • TES Systems using Waste Heat from Textile, Cement and Steel Casting Industry • TES Systems for Concentrating Solar Power (CSP) Technology 		14
	Total		45

- g. Details of lab work, workshops practice (if applicable).
No lab is required.

Recommended Reading (including Textbooks and Reference books).

S. No.	Title	Author(s)	Remarks
1.	Thermal Energy Storage; Systems and Applications, Second Edition, John Wiley & Sons, New York, 2011	İbrahim Dincer Marc A. Rosen	Text Book
2.	Sustainable Thermal Storage Systems: Planning, Design, and Operations, McGraw-Hill, 2011	Lucas B. Hyman	Reference Book
3.	Thermal Energy Storage and Regeneration, McGraw Hill, 1981	F.W. Schmidt and A.J. Willmott	Reference Book
4.	Thermal Energy Storage for Sustainable Energy Consumption; Fundamentals, Case Studies & Design, Springer, 2007	Haline Ö. Paksoy	Reference Book

h. Details of online resources

(1) http://www.engineeringtoolbox.com/sensible-heat-storage-d_1217.html

i. Recommended journals

- (1) Renewable and Sustainable Energy Reviews
- (2) Applied Thermal Engineering
- (3) Renewable Energy
- (4) Solar Energy