FACULTY OF ENGINEERING & TECHNOLOGY

First Year Master of Engineering

Semester I

Course Code: 102440107

Course Title: Energy Storage Systems

Type of Course: Program Elective II

Course Objectives: To provide an insight into the various modes of energy storage. To impart knowledge on construction, working principle and performance analysis of electrochemical, electric and thermal storage systems

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Internal		External		Total
Lecture	Tutorial	Practical		Theory	J/V/P*	Theory	J/V/P*	
3	0	2	4	40 /16	20 /08	60 /24	30 /12	150 /60

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	ENERGY STORAGE MODES Potential energy, Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors, electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, Superconducting Magnet Energy Storage (SMES) systems.	10
2	ELECTROCHEMICAL ENERGY STORAGE SYSTEMS Batteries- primary, secondary, Lithium; Solid-state and molten solvent batteries; Lead acid batteries; Nickel Cadmium batteries; Advanced batteries, Role of carbon nano-tubes in electrodes	10
3	ELECTRIC ENERGY STORAGE SYSTEMS Capacitor and Batteries: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor (EDLC), principle of working, structure, performance and application, role of activated carbon and carbon nano-tube.	10
4	SENSIBLE AND LATENT HEAT STORAGE SHS mediums; Stratified storage systems; Rock-bed storage systems; Thermal storage in buildings; Earth storage; Energy storage in aquifers, Phase Change Materials (PCMs); Selection criteria of PCMs; solar thermal LHTE systems.	9
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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks						**R**: Remembering; **U**: Understanding; **A**: Application, **N**: Analyze; **E**: Evaluate; **C**: Create
R	**U**	**A**	**N**	**E**	**C**	
10%	30%	30%	20%	10%	0%	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1	Thermal Energy Storage Systems and Applications, Ibrahim Dincer and Mark A Rosen, Wiley
2	Fuel cell systems Explained, James Larminie and Andrew Dicks, Wiley Publications
3	Electrochemical technologies for energy storage and conversion, Ru-shiliu, Leizhang, Xueliang sun, Wiley Publications
4	Energy storage, Yves Brunet. Wiley Publication
5	Advances in thermal energy storage systems, Luisa F.Cabeza., Woodhead publications
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Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Students able to understand the need of energy conversion and the various methods of energy storage	**15**
CO-2	Students able to understand the principle of electro chemical and electrical energy storage system	**25**
CO-3	Students able to demonstrate the mechanical, electro chemical and electrical energy storage system	**25**
CO-4	Students able to identify available technologies and materials for energy storage and their typical application areas	**20**
CO-5	Students able to summarize the demand for further development, potential improvements and possibilities for innovative solutions in the energy storage field	**15**
CO-6	Click or tap here to enter text.	Click
CO-7	Click or tap here to enter text.	Click
CO-8	Click or tap here to enter text.	Click
CO-9	Click or tap here to enter text.	Click
CO-10	Click or tap here to enter text.	Click

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List of Practicals / Tutorials:

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1	Study of Battery charging and discharging characteristics
2	Combine AC and DC load system with battery
3	Evaluation of heat transfer during charging and discharging of Phase Change Material (PCM)
4	Inspection of temperature distribution inside the PCM
5	Evaluation of system thermal efficiency during charging storing and discharging the PCM
6	Evaluation of overall system thermal efficiency
7	Study of electrochemical storage system
8	Study of electric storage system
9	Study of thermal energy storage in building
10	Study of Superconducting Magnet Energy Storage (SMES) systems
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Supplementary learning Material:	
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Curriculum Revision:	
Version:	**1**
Drafted on (Month-Year):	Apr-20
Last Reviewed on (Month-Year):	Jul-20
Next Review on (Month-Year):	Apr-22

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