

Reg. No.

Question Paper Code

13220

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2024

Seventh Semester

Electrical and Electronics Engineering

20EEEL712 - ENERGY STORAGE TECHNOLOGIES

Regulations - 2020

Duration: 3 Hours

Max. Marks: 100

**PART - A (MCQ) (20 × 1 = 20 Marks)**

Answer ALL Questions

Marks K-  
Level CO

1. Which of the following factors does NOT affect energy demand variations? 1 K1 CO1  
 (a) Weather conditions (b) Time of day  
 (c) Geographic location (d) Type of energy source
2. Which of the following is a major benefit of using energy storage systems in the power grid? 1 K1 CO1  
 (a) Increased fossil fuel consumption (b) Improved grid stability and reliability  
 (c) Decreased renewable energy use (d) Higher energy prices for consumer
3. Which of the following practices can help improve energy sustainability? 1 K1 CO1  
 (a) Increasing fossil fuel extraction (b) Reducing energy efficiency  
 (c) Promoting energy conservation (d) Limiting renewable energy use
4. Which term describes the sudden loss of electrical power across a region? 1 K1 CO1  
 (a) Power surge (b) Blackout (c) Brownout (d) Overload
5. In a pumped hydro storage system, potential energy is stored in: 1 K1 CO2  
 (a) Compressed air (b) Elevated water reservoirs  
 (c) Chemical bonds (d) Rotating flywheels
6. What is a common material used for thermal energy storage with phase change? 1 K1 CO2  
 (a) Hydrogen (b) Methane (c) Oxygen (d) Nitrogen
7. Which of the following factors does NOT affect energy demand variations? 1 K1 CO2  
 (a) Weather conditions (b) Time of day  
 (c) Geographic location (d) Type of energy source  
 What is the main advantage of capacitors over batteries? 1 K1 CO2
8. (a) Higher energy density (b) Faster charge and discharge rates  
 (c) Longer lifespan (d) Higher thermal stability
9. The term 'C-rate' in relation to battery discharge refers to: 1 K1 CO3  
 (a) The current output of the battery.  
 (b) The charge rate of the battery.  
 (c) The rate at which a battery is charged or discharged relative to its capacity.  
 (d) The efficiency of the battery.
10. Which of the following energy storage systems typically provides the highest cycle lifetime? 1 K1 CO3  
 (a) Lead-acid batteries (b) Lithium-ion batteries  
 (c) Pumped hydroelectric storage (d) Flywheel storage systems
11. What is the main advantage of flow batteries over traditional batteries in terms of cycle lifetime? 1 K1 CO3  
 (a) Higher energy density (b) Unlimited charge-discharge cycles  
 (c) Easily replaceable electrolytes (d) Higher voltage stability
12. Which of the following components in batteries is considered a significant environmental pollutant when disposed of improperly? 1 K1 CO3  
 (a) Copper (b) Cadmium (c) Iron (d) Magnesium

- |   |   |    |     |
|---|---|----|-----|
| 13. A battery has a capacity of 10 Ah and operates at 12 V. How much energy does the battery store?               | 1 | K2 | CO4 |
| (a) 10 Wh.                      (b) 120 Wh.                      (c) 1.2 kWh.                      (d) 12 kWh.    |   |    |     |
| 14. The main reason for the voltage drop in a battery under load is due to  | 1 | K1 | CO4 |
| (a) Increase in temperature.                      (b) Decrease in temperature.                                    |   |    |     |
| (c) Internal resistance.                      (d) External load.  |   |    |     |
| 15. During which phase of charging does a lithium-ion battery charge most rapidly?                                | 1 | K1 | CO4 |
| (a) Constant Voltage phase                      (b) Constant Current phase  |   |    |     |
| (c) Trickle Charge phase                      (d) All phases equally  |   |    |     |
| 16. Which is a challenge when integrating hybrid energy storage systems?  | 1 | K1 | CO4 |
| (a) High energy output                      (b) Excessive system weight   |   |    |     |
| (c) Complex control mechanisms                      (d) Low energy capacity                                       |   |    |     |
| 17. Which type of charging pattern is typically used for Lithium-ion batteries to prolong battery life?           | 1 | K1 | CO5 |
| (a) Constant voltage charging                      (b) Pulsed charging  |   |    |     |
| (c) Constant current, then constant voltage                      (d) Fast charging only                           |   |    |     |
| 18. Which function does a BMS NOT perform?  | 1 | K1 | CO5 |
| (a) Temperature monitoring                      (b) Current management  |   |    |     |
| (c) Data encryption                      (d) Voltage balancing  |   |    |     |
| 19. Which of the following is a major area of application for battery energy storage in renewable energy systems? | 1 | K1 | CO5 |
| (a) Greenhouse gas production                      (b) Solar energy storage                                       |   |    |     |
| (c) Fossil fuel backup systems                      (d) Diesel generators   |   |    |     |
| 20. What is the primary risk of overcharging a lithium-ion battery?   | 1 | K1 | CO5 |
| (a) Reduced voltage                      (b) Battery swelling or explosion  |   |    |     |
| (c) Loss of electrolyte                      (d) Decrease in weight   |   |    |     |

**PART - B (10 × 2 = 20 Marks)**

Answer ALL Questions

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|---|---|----|-----|
| 21. Define Superconducting Magnetic Energy.                                   | 2 | K1 | CO1 |
| 22. What is the function of flow battery?                                     | 2 | K1 | CO1 |
| 23. What are the properties of molten salt?                                   | 2 | K1 | CO2 |
| 24. Interpret how thermal energy increase during a phase change.              | 2 | K2 | CO2 |
| 25. What factors influence the discharge rate of a battery?                   | 2 | K1 | CO3 |
| 26. What does dispatch-ability mean in the context of energy storage?         | 2 | K1 | CO3 |
| 27. Compare hybrid and plug-in hybrid.  | 2 | K2 | CO4 |
| 28. Why is the Lithium-Ion battery more efficient than the Lead-Acid battery? | 2 | K1 | CO4 |
| 29. List two ways in which a BMS protects a battery.                          | 2 | K1 | CO5 |
| 30. What is the difference between fast charging and trickle charging?        | 2 | K1 | CO5 |

**PART - C (6 × 10 = 60 Marks)**

Answer ALL Questions

- |   |    |    |     |
|---|----|----|-----|
| 31. a) Explain how we align energy production with varying scale requirements, from small-scale residential to large-scale industrial needs.  | 10 | K2 | CO1 |
| <b>OR</b>   |    |    |     |
| b) Explain the rising demand for portable energy solutions in today's society. How are advancements in battery technology and alternative fuels meeting this demand and what challenges remain? | 10 | K2 | CO1 |

32. a) Explain how pumped hydro systems can be optimized for efficiency and minimal energy loss. 10 K2 CO2
- OR**
- b) Classify the types of electrochemical energy storage systems. Compare and contrast batteries and fuel cells in terms of their chemistry, performance, applications and challenges. 10 K2 CO2
33. a) Explain the load flowing characteristics of energy storage systems. 10 K2 CO3
- OR**
- b) Explain the key factors affect industrial battery efficiency. 10 K2 CO3
34. a) Explain how super capacitors can be used to handle both peak power needs and energy requirements in hybrid systems. 10 K2 CO4
- OR**
- b) Explain the lifetime and stability of a Bacitor system and compare to a standalone battery or capacitor. 10 K2 CO4
35. a) Explain how does the energy density of lead-acid batteries compare to that of lithium-ion batteries and what implications does this have for various applications? 10 K2 CO5
- OR**
- b) Summarize the choice of battery type which affects energy storage for automotive applications, especially in electric and hybrid vehicles. 10 K2 CO5
36. a) i) Summarize the main challenges and limitations of current hydrogen storage technologies. 5 K2 CO4
- ii) Explain the Mechanism of Reversible Reactions in Battery Operation. 5 K2 CO5
- OR**
- b) i) Outline the hydrogen production technologies in the areas lacking a renewable energy infrastructure. 5 K2 CO4
- ii) Explain the Role of Battery Storage in Hybrid and Electric Vehicles. 5 K2 CO5