Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem Examination May-2024

OE00094

Battery Management Systems & Charging Stations

Programme: B.Tech. Branch/Specialisation: All

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. What is the typical voltage range of a lithium-ion battery cell? **1**

(a) 1.2V – 1.5 V (b) 1.5 V – 1.9 V

(c) 3.6 V – 3.7 V (d) 10V – 12 V

ii. Which battery type typically requires periodic watering to maintain electrolyte levels? **1**

(a) Lithium-ion (b) Nickel-cadmium

(c) Lead-acid (d) Lithium polymer

iii. What does CC charging stand for in the context of battery charging? **1**

(a) Constant current (b) Continuous charging

(c) Charging capacity (d) Current control

iv. Which balancing method involves charging each cell individually to ensure they reach the same state of charge? **1**

(a) Battery sorting

(b) Overcharge for balancing

(c) Passive balancing

(d) Active balancing

v. The charging speed at a normal charging station is typically: **1**

(a) Slow (b) Moderate (c) Fast (d) Ultra-fast

vi. In which type of charging station do users have the option to exchange their depleted battery for a fully charged one? **1**

(a) Domestic charging infrastructure

(b) Occasional charging station

(c) Fast charging station

(d) Battery swapping station

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vii. In a battery-pack topology, what does “parallel connection” involve? **1**
(a) Connecting battery cells in a series
(b) Connecting battery cells in parallel to increase capacity
(c) Connecting battery cells to the BMS
(d) Connecting battery cells to the charger

viii. What is the primary purpose of current sensing in a BMS design? **1**
(a) Monitoring battery voltage
(b) Monitoring battery temperature
(c) Monitoring battery capacity
(d) Monitoring battery charging and discharging currents

ix. What is a common general approach to modeling batteries? **1**
(a) Analytical equations only
(b) Empirical data only
(c) Combining analytical equations and empirical data
(d) Using only simulation software

x. What is the primary purpose of simulating rechargeable batteries? **1**
(a) To accurately predict their behavior under different conditions
(b) To manufacture batteries more efficiently
(c) To study the history of battery technology
(d) To determine the chemical composition of batteries

Q.2 i. Explain the concept of nominal voltage and capacity in cells and batteries. Why are they important in battery selection and usage? **2**

ii. Highlight the advantages and disadvantages of lead-acid batteries and their suitability for different applications. **3**

iii. Provide an overview of lithium batteries, including lithium polymer and lithium-ion variants. What are the key differences between these two types of lithium batteries in terms of construction, performance and application? **5**

OR iv. Define the C rate in battery terminology. How does it impact the charging and discharging processes of a battery? Provide examples to illustrate the significance of the C rate in practical applications. **5**

Q.3 i. What is Multi-Stage Constant Current (MSCC) charging? What are the distinct stages involved in MSCC charging? **2**

ii. How does the Constant Current (CC) charging algorithm work? What are its advantages and limitations compared to other charging methods? **8**

OR iii. Discuss Constant Voltage (CV) charging as applied to lead-acid batteries. How does CV charging differ from CC charging? **8**

Q.4 i. Discuss the advantages and limitations of domestic charging infrastructure and public charging infrastructure for electric vehicles. **3**

ii. Explain the concept of a normal charging station and its role in supporting electric vehicle adoption. How does a normal charging station differ from other types of charging infrastructure? **7**

OR iii. Analyze the impact of fast charging stations on electric vehicle adoption and usage patterns. Evaluate the challenges and opportunities associated with the widespread deployment of fast charging stations. **7**

Q.5 i. What strategies are commonly employed for thermal control and protection in battery systems? **4**

ii. Explain the importance of accurate voltage, temperature, and current sensing in a BMS. How do these sensing techniques contribute to battery health monitoring and fault detection? **6**

OR iii. How does the choice of battery-pack topology impact the overall performance of an electric vehicle? What factors should be considered when selecting a topology for a specific application? **6**

Q.6 Attempt any two:

i. What are the fundamental principles and considerations involved in developing a general approach for modelling batteries? Discuss the key factors to accurately represent battery in simulation environments. **5**

ii. In the context of rechargeable Li-ion batteries, how do simulation models capture the complex electrochemical processes exhibited during charge and discharge cycles? **5**

iii. Discuss the significance of accurately representing the voltage-current characteristics, capacity fade, and internal resistance effects in the simulation model of a rechargeable NiCd battery. **5**

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Marking Scheme

Battery Management Systems & Charging Stations (T)-OE00094(T)

Q.1	i)	What is the typical voltage range of a lithium-ion battery cell? c) 3.6 V – 3.7 V	**1**
	ii)	Which battery type typically requires periodic watering to maintain electrolyte levels? c) Lead-acid	**1**
	iii)	What does CC charging stand for in the context of battery charging? a) Constant Current	**1**
	iv)	Which balancing method involves charging each cell individually to ensure they reach the same state of charge? c) Passive balancing	**1**
	v)	The charging speed at a normal charging station is typically: a) Slow	**1**
	vi)	In which type of charging station do users have the option to exchange their depleted battery for a fully charged one? d) Battery swapping station	**1**
	vii)	In a battery-pack topology, what does “parallel connection” involve? b) Connecting battery cells in parallel to increase capacity	**1**
	viii)	What is the primary purpose of current sensing in a BMS design? d) Monitoring battery charging and discharging currents	**1**
	ix)	What is a common general approach to modeling batteries? c) Combining analytical equations and empirical data	**1**
	x)	What is the primary purpose of simulating rechargeable batteries? a) To accurately predict their behavior under different conditions	**1**
Q.2	i.	Explain the concept of nominal voltage and capacity in cells and batteries…….. 1 Mark Important in battery selection and usage……. 1 Mark	**2**
	ii.	Highlight the advantages and disadvantages …. Each 1 Mark, 3 highlights……. 3 Marks.	**3**
	iii.	Overview of lithium polymer battery …… 1 Mark Overview of lithium-ion battery ……. 1 Mark Differences between lithium-ion and lithium polymer batteries …. …… 3 Marks	**5**
OR	iv.	Define the C rate in battery terminology……. 1 Mark Impact the charging and discharging processes … 2 Marks	**5**
		Provide examples …… 2 Marks	
Q.3	i.	What is Multi-Stage Constant Current (MSCC) charging. 1 Mark Distinct stages involved in MSCC charging……. 1 Mark	**2**
	ii.	Explain Constant Current (CC) charging algorithm …. 4 Marks Advantages and limitations ……. 4 Marks	**8**
OR	iii.	Discuss Constant Voltage (CV) charging …… 4 Marks Comparison of CV charging and CC charging……. 4 Marks	**8**
Q.4	i.	Advantages and limitations each 1 Marks … .. 3 advantage and limitations…….. 3 Marks	**3**
	ii.	Explain the concept and role of a normal charging station …. 3 Marks Comparison of a normal charging station with other types of charging infrastructure…… 4 Marks	**7**
OR	iii.	Analyze the impact of fast charging stations …….. 4 Marks Evaluate the challenges and opportunities ……... 3 Marks	**7**
Q.5	i.	Strategies for thermal control and protection in battery systems… 4 Marks	**4**
	ii.	Importance of accurate voltage…… 1 Mark, Importance of temperature……. 1 Mark, Importance of current sensing …… 1 Mark Contribution of voltage, current, and temperature sensing to battery health monitoring and fault detection…… 3 Marks	**6**
OR	iii.	impact the overall performance of an electric vehicle due to choice of battery-pack topology…… 3 Marks Factors for selection of a battery-pack topology …… 3 Marks	**6**
Q.6	i.	General approach to modelling batteries……. 3 Marks Key factors to accurately represent battery…….. 2 Marks	**5**
	ii.	how do simulation models capture the complex electrochemical processes exhibited during charge and discharge cycles…….. 5 Marks	**5**
	iii.	Significance of accurately representing the voltage-current characteristics…… . 2 Marks Significance of accurately representing the capacity fade ….. 1 Marks Significance of accurately representing the internal resistance…. 2 Marks	**5**

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