Question Paper

Exam Date & Time: 08-May-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

SIXTH SEMESTER B.TECH END SEMESTER EXAMINATIONS, APRIL-MAY 2024

BATTERY AND FUEL CELL TECHNOLOGY [AAE 4042]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1)		How does the kinetics of an electrochemical cell take place, use a visual representation of the electrical double layer and explain the role in cell operation.	(4)
	A)		
	B)	State the below equations and mention the terminologies about electrochemistry: (a) Nernst equation (b) Butler Volmer equation	(2)
	C)	How are cell materials harvested, and what steps are involved in their subsequent analysis?	(4)
2)		Elaborate on the design and operation of a Molten Carbonate Fuel Cell?	(4)
	A)		
	B)	State the difference between battery and fuel cells. Classify fuel cells based on operating temperature.	(3)
	C)	Identify and elucidate the various types of losses occurring during the operation of a PEM fuel cell	(3)
3)		How would you evaluate and analyse the thermal management strategies implemented in hydrogen fuel cells?	(4)
	A)		
	B)	Why is battery safety considered a topic that requires understanding across multiple disciplines?	(3)
	C)	Analyze the functioning of the water-cooling subsystem within hydrogen fuel cells?	(3)
4)		Sketch and analyse the various components comprising the architecture of an automotive battery system	(4)
	A)		
	B)	Discuss the role of finite element modelling of batteries and its impact on failure evaluation of battery pack	(3)
	C)	Identify and describe the various forms of abuse that can lead to thermal runaway in batteries	(3)
5)		How would you analyse the gases produced during battery thermal runaway, considering both the experimental methods and underlying principles involved?	(4)
	A)		
	B)	Discuss wheel-to-well calculation. Calculate the motor power required to accelerate from 0-40 kmph speed, also calculate the total number of cells, cells in series and parallel for the assembly of the battery pack with 48 V with a single cell current of 2.8 A is used. Use the specifications from the tables below. Table 1 provides insights about the vehicle specification and Table 2 provides insights for cell specification.	(4)

Table 1.

Sl No	Specifications	Value	Units
1	Kerb mass of the vehicle	111	Kg
2	Driver Mass	80	Kg
3	Gravity (g)	9.81	m/s
4	Gear ratio (D) (Belt drive)	7.8:1	
5	Efficiency of Transmission (N_{eff})	0.85	
6	Top speed	80	kmph
7	Acceleration performance	0 - 40 kmph in 3.9 s	
8	**Range** Eco mode	75	Km

	Ride mode Sport mode	65 55	Km km
9	**Wheel size** Front Rear	 12 12	 Inch Inch
10	Drag Coefficient Coefficient of Rolling Resistance Frontal Area	0.22 0.015 0.875	 m^2

Table 2.

Sl No	Specification	Data
1	Manufacture	Panasonic
2	type	Cylindrical
3	model	NCR186500B
4	Length	0.0653
5	diameter	0.0185
6	height	0
7	Width	0
8	Thickness	0
9	Mass	0.048
10	capacity	3.2
11	Nominal Voltage	3.6
12	Over & under voltage	4.2 & 2.8
12	C-rate	1

13	C-rate (peak)	1.2

C) As a continuation of the above question, calculate the total number of cells, cells in series and parallel for the assembly of the battery pack with 48 V with a single cell current of 2.8 A is used to deliver the power calculated. Consider 5% losses from the motor to the battery. (2)

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