U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**

Branch: Mechanical Engineering **Duration: 3 hrs.**

Course Code: 23ME5PEEHV /22ME5PEEHV/ 21ME5DEEV1 **Max Marks: 100**

Course: Electric and Hybrid Vehicles

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

		UNIT - I	CO	PO	Marks
1	a)	**A 2**-wheeler uses 25 Wh/km. We need a battery with 80 km range. Effective Use of Battery: 0.85 * Capacity i. Calculate the size of battery required. ii. Estimate the cost of the battery (use linear interpolation when required) using data given.	CO1	PO1	**06**

Battery Size (kWh)	**1**	**2**	**3**	**4**
Battery Cap Cost (Rs)	18,000	33,000	45,000	54,000
Energy Eff (Wh/km)	Range with Battery Size (kWh)			
15	56.7	113.3	170.0	226.7
20	42.5	85.0	127.5	170.0
25	34.0	68.0	102.3	136.0
30	28.3	56.7	85.0	113.3

	b)	Discuss Hybrid electrical vehicle. Compare different types of hybrid levels in EVs	CO1	PO1	**06**
	c)	Sketch different types of EV Configuration	CO1	PO1	**08**
		OR			
2	a)	A decent sized Petrol four-wheeler consume 15 kms per litre and Equivalent EV consume 150 Wh / km with battery cells being 250 Wh/kg and 500 Wh/ltr. Petrol energy is 45 megajoules per kilogram (MJ/kg) and its density is 0.75 kg/L. Compute 1. i)the ratio of Energy Efficiency of EV Vs ICE (Internal Combustion Engine) vehicle	CO1	PO2	**10**

<table>
<tr><td></td><td></td><td></td><td>2. ii)Ratio of Battery weight and petrol weight per km of travel by two vehicles

iii)Ratio of Battery volume and petrol volume per km of travel by two vehicles
Based on this, comment on the advantage and disadvantages of EV.</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>b)</td><td>With the help of block diagram explain general EV configuration</td><td>CO1</td><td>PO1</td><td>10</td></tr>
<tr><td></td><td></td><td></td><td>UNIT - II</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td>a)</td><td>A vehicle needs to reach maximum speed vf in T seconds. Derive expressions for average power and peak power i) if it accelerates linearly.

ii)ifit accelerates at a rate “a1” for first T/2 time and at a rate “a1/2” from T/2 to T.Hence prove that peak power reduces to 2/3 rd of the peak power required for linear acceleration</td><td>CO2</td><td>PO2</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>Compute total traction force assuming pick-up from 0 to 50 kmph in 20 sec, with linear acceleration and zero slope.
,μ=0.015 and ρ = 1.2 kg/m3.
<table>
<tr><td>Vehicle</td><td>GVW (kg)</td><td>CD</td><td>Area (m2)</td><td>μ</td><td>V1 (km/h)</td><td>V2 (km/h)</td><td>Tyre Radius (m)</td></tr>
<tr><td>3-wheeler</td><td>600</td><td>0.45</td><td>1.6</td><td>0.015</td><td>30</td><td>80</td><td>0.2</td></tr>
</table></td><td>CO2</td><td>PO2</td><td>10</td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td>a)</td><td>Compute Forces due to drag, rolling resistance and gradient for the following vehicles assuming ρ = 1.2 (kg/m3) and θ = 8°. For the vehicle given in the table, find Aerodynamic drag at velocity v1 and v2; also find rolling resistance at two velocities.

compute total traction force assuming pick-up from 0 to 50 kmph in 20 sec, with linear acceleration and zero slope.
<table>
<tr><td>Vehicle</td><td>GVW (kg)</td><td>CD</td><td>Area (m2)</td><td>μ</td><td>V1 (km/h)</td></tr>
<tr><td>4-wheeler</td><td>1500</td><td>0.3</td><td>2.5</td><td>0.015</td><td>30</td></tr>
</table>
also compute the power and torque at v = 30 km/h, 50 km/h and 80 km/h</td><td>CO2</td><td>PO2</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>Define drive cycle? With an example explain how much energy will a vehicle take per km?</td><td>CO2</td><td>PO1</td><td>10</td></tr>
</table>

			UNIT - III			
	5	a)	Explain the following with respect to battery i. State of Charge (SoC) ii. EV Battery Life iii. Depth of Discharge (DoD) iv. useable capacity v. C Charge	*CO3*	*PO1*	**10**
		b)	Battery has initial rated capacity of 10 kWh at 48V. Battery is charged using standard charging conditions. Coulomb counting indicates a charge of 30Ah has flown in before termination of charge. What will be the % SOC change when (a) SoH is 90% and (b) SoH is 85%. (Here SoH refers to capacity fade)	*CO3*	*PO2*	**10**
			OR			
	6	a)	Explain the Factors affecting Battery cell life cycles with graphs.	*CO3*	*PO1*	**10**
		b)	A Li Ion cell when charged fully has an Internal resistance of 20 mΩ at BoL.At its EoL the cell suffers a 150% rise in its internal resistance at full charge. Determine the max peak instantaneous current the cell can support at its BoL and EoL.	*CO3*	*PO2*	**05**
		c)	A li Ion cell 3.65V, 15Ah with 88% SoH is charged fully (0 to 100% SoC) and is being used to power a load demanding continuous current of 1C. How long can the cell power the load?	*CO3*	*PO2*	**05**
			UNIT - IV			
	7	a)	What are the factors to be considered in the design of the Battery Pack? Explain	*CO4*	*PO1*	**10**
		b)	A battery pack of 375V, 200Ah is to be made to power a luxury car. One battery pack is made with 3.65V, 4Ah, 21700 Cylindrical cells and another pack uses 3.65V, 50Ah prismatic cells. a. Suggest nPmS configuration for each case to achieve the pack requirements. b. Find the total number of cells in both cases. c. A cell in module of n parallel cells fails in open during operation. Find the resultant nominal pack voltage in V, pack capacity (Ah) for both the packs.	*CO4*	*PO1*	**10**
			OR			
	8	a)	Explain Constant current (CC) charging and Constant-voltage (CV) charging.	*CO4*	*PO1*	**10**
		b)	A Battery pack of configuration 2P14S is made with 3.65V, 13Ah Li Ion cells to power a two wheeler. The pack is used in field for some time and has undergone 5% degradation. The pack operation is limited from 10% SoC to 90% SoC level to improve life. a. Indicate the SoH (%) of this battery pack and DoD of operation. b. What is the nominal voltage of pack and the capacity in kWh. c. What is the usable capacity (kWh) of battery pack at current level of SoH.	*CO4*	*PO1*	**10**

			UNIT - V			
	9	a)	With a block diagram explain the level 1 and level 2 AC chargers for EV	*CO5*	*PO1*	**10**
		b)	Write the block diagram of Charging Infrastructure and Protocols.	*CO5*	*PO1*	**10**
			OR			
	10	a)	Why Standardize battery charging? What are the Parameters that need Standardization, explain	*CO5*	*PO1*	**10**
		b)	Write the block diagram of Authorization Flow Using Mobile Application in battery charging application.	*CO5*	*PO1*	**10**

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