

Q.1.

A fuel cell electric hybrid vehicle has the following parameters.

Parameters	Value	Unit
Vehicle glider mass, m	592	kg
Gravity, g	9.81	m/s^2
Rolling resistance coefficient, f_r	0.009	—
Transmission efficiency, η_t	0.92	—
Air density, ρ_a	1.2	kg/m^3
Aerodynamic drag coefficient, C_d	0.335	—
Frontal area, A_f	2.0	m^2
Wheel radius	0.282	m
Average electrical accessory load	700	W
Vehicle cargo mass	136	kg
Electric motor mass	91	kg
Fuel cell system mass	223	kg

- Determine the base power provided by the fuel cell system if the cruise speed is 60km/hr. Make suitable assumptions for transmission and motor efficiency
- If the vehicle has to accelerate to 60km/hr in 40s, determine the total electric power required by the vehicle
- It is proposed to have either a battery or ultracapacitor for this hybrid system. Design these sources to provide the dynamic power. Determine the battery module and capacitor bank module's specifications (no. of cells) Compare and write your conclusions. The specifications for the battery and ultracapacitor are given below.

Manufacturer	A123-Systems
Type	pouch
Model	26Ah
Source	[7]
Length [m]	0
Diameter [m]	0
Height [m]	0.227
Width [m]	0.16
Thickness [m]	0.00725
Mass [kg]	0.496
Capacity [Ah]	19.5
Voltage [V]	3.3
C-rate (cont.)	1
C-rate (peak)	10

Cell Capacitance (F)	Weight Per cell (kg)	ESR (mΩ)	Specific Energy (Wh/kg)	Specific Power (W/kg)	Cell Voltage (V)	Time Constant ($\tau=RC$)
2700	0.52	0.6	2.49	8929	2.5	1.6

Make suitable assumptions for the efficiencies and write any other assumptions made.

[15 Marks]