(3 Hours) **[Total Marks: 80]**

Note:

1. Question No. 1 is compulsory
2. Solve any three questions out of remaining five questions
3. Assume suitable additional data if necessary
4. Figure on right indicates full marks

Q1	a.	Explain historical background of EV and HEV technology involvement	5
	b.	State and explain the dynamic equation of vehicle motion	5
	c.	Derive closed loop transfer function of current controlled PI controller for inverter	5
	d.	Comment on the suitability of DC and AC machines for electric and hybrid electric vehicle applications	5
Q2	a.	A 12V battery pack is connected to series RL load with L=100mH.The battery pack has rated capacity of 120Ah. At t=0 switch is closed and the battery begins to discharge. a) Calculate and plot battery discharge current i(t), if the steady state discharge is C/5.Neglect voltage drop. b) Calculate and plot SoC, assuming that t=0, the battery is charged to rated capacity. c) Calculate the time according to 70% DoD, assume t>>100ms.	10
	b.	Draw and explain the ideal traction power plant characteristic and various power source characteristics used in electric and hybrid electric vehicles	10
Q3	a.	Enlist the different architectures of hybrid electric drive train and explain the series hybrid electric drive train	10
	b.	Describe in detail all modes of operation for series-parallel hybrid vehicle.	10
Q4	a.	Explain the two-quadrant operation of chopper DC motor drive with suitable waveforms for electric vehicle	10

	b.	A dc separately excited motor is powered by a dc to dc converter from a 600 volts dc source. The armature resistance is 0.05 Ω. The back emf constant of the motor is 1.527 V/A rad/sec. The average armature current is 250 amps. The field current is 2.5 amps. The armature current is continuous and has negligible ripple. If the duty cycle of the converter is 60%, determine (a) the input power from the source, (b) the equivalent input resistance of the dc-dc converter drive, (c) the motor speed, and (d) the developed torque	10
Q5	a.	What are different modes of charging batteries? Compare them in detail.	10
	b.	Explain fuel cell and flywheel as energy source elements in electric and hybrid electric vehicle	10
Q6	a.	Draw and explain the typical CAN system of a hybrid electric vehicle	10
	b.	Classify and explain the basic principle of Rule based energy management system. Elaborate on any one of the Rule based energy management system	10
