Time: 3 hour **Max. Marks: 80**

Note :

- **Question No.1 is compulsory.**
- Solve **ANY THREE** questions from the **remaining** questions.
- Figure to the right indicates full marks.

			Marks
Q. 1		Solve **ANY FOUR** questions from following. (Each question carries 5 marks)	
	a)	Draw the schematic of general configuration of electrical subsystem of an Electric Vehicle (EV) and a Hybrid Electric Vehicle (HEV)	5
	b)	What is the need and importance of electric vehicle?	5
	c)	Describe the concept of "Hybridness" and classify the HEV based on hybridness.	5
	d)	Draw and explain the ideal traction energy source (power plant) characteristic used in EV/HEVs	5
	e)	The use of battery & ultra-capacitor as well fuel-cell & flywheel to form a hybrid energy source for EV application..	5
Q. 2	a)	Draw any one standard driving cycle and relate its application for EV performance analysis.	**6**
	b)	Illustrate the fuel efficiency of ICE based conventional vehicles and Electric Vehicle with the help of neat diagrams and compare their overall performance.	**6**
	c)	Explain the two quadrant operation of chopper dc motor drive with suitable waveforms for electric vehicle.	**8**
Q3	a)	Draw and explain the ideal traction energy source (power plant) characteristic and various energy source characteristics used in EV/HEVs.	**6**
	b)	State and define the key battery parameters (i) Battery capacity (ii) C rate (iii) SoC (iv) DoD (v) Specific Energy (vi) Energy Density.	**6**
	c)	What are the different battery charging modalities adopted for EV? Explain each one in brief and also elaborate on standards adopted for the same worldwide.	**8**

Q4	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**
Q5	a)	Draw and explain the typical CAN system of a hybrid electric vehicle.	**10**
	b)	Enlist the different architectures of hybrid electric drive train and explain the series hybrid electric drive train.	**10**
Q6	a)	Classify and describe in brief about the basic principle of optimization-based energy management system used in EV/HEVs. Elaborate on any one of the optimization-based energy management system	**10**
	b)	Illustrate with the help of diagrams, various components which contribute to the total tractive effort (FTE) needed in EV. Describe each in brief and also derive the expression for FTE by means of electric vehicle performance modeling.	**10**

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