(Time: 3 Hours) Q. P. Code: 18160

[Maximum Marks: 80]

1. Q. 1 is compulsory
2. Answer **any three** out of remaining **five** questions.
3. Assumptions made should be clearly stated.
4. Assume any suitable data wherever required but justify the same.

(a) Compare the performance of ICE based conventional vehicles and Electric Vehicle. Explain the general configuration electrical subsystem of an Electric Vehicle 05

(b) Compare the characteristics and performance of batteries, Fuel Cell and ultra-capacitor for an EV application. 05

(c) Define the Hybridness (H) for a hybrid EV. Classify the HEV based on hybridness. 05

(d) Explain briefly the performance parameters of the vehicle 05

(a) A 96V battery pack is connected to a series RL load with L=150mH. The battery pack has a rated capacity of 150Ahr. At t=0, the switch is closed, and the battery begins to discharge. Calculate the battery discharge current, if the steady state discharge rate is C/2. Neglect battery voltage drop. 10

(b) Draw and explain the architecture and power flow control of series and parallel hybrid electric drive train 10

(a) Describe the battery charging methods used in EV/ PHEV in detail. 10

(b) Elaborate on batteries and super-capacitors as energy source elements in electric and hybrid electric vehicles 10

(a) What are the various components which contribute to the total tractive effort (F_{TE}) needed in EV/HEV? Describe each of them in brief and also derive the expression for F_{TE} by means of electric vehicle performance modeling. 10

(b)State and explain the Vehicle to Grid (V2G) and Grid to Vehicle (G2V) operation in electric vehicle technology. 10

5 (a) Explain the evaluation of EV performance using a drive cycle. Draw any one driving cycle and explain. 10

(b) A DC-DC converter used in a three wheeler EV drive is fed from a battery pack of 220V produces output voltage V_o= 390V at output power P_o=25kW. If the converter is to be operated in current control mode, then derive the open loop and closed loop transfer function of converter. Design a PI controller for closed loop operation of this converter with components L = 0.35mH, r_L (resistance of L) = 0.012Ω, C= 2200 μF and f_s =15 kHz. 10

6. (a) Classify and explain the basic principle of a rule based energy management system. Elaborate on any one of the rule based energy management system 10

(b) State and explain the design considerations for the battery, electric motor and power converter to be used in (i) EV two wheeler (ii) A small utility vehicle EV. 10
