Q.P. Code : 734700

( 3 Hours ) [ Total Marks : 80

N.B.: (1) Question **No.1** is **compulsory**.
(2) Answer **any Three** out of remaining **Five** questions.
(3) Use **graph paper** wherever **necessary**.
(4) Assumptions made should be **clearly** stated.
(5) Assume any suitable **data** wherever **required** but **justify the same**.

1. (a) Answer the following (**Any Three**) : 12
(i) Compare the performance of ICE based conventional vehicles and Electric Vehicle.
(ii) Explain the general configuration electrical subsystem of an Electric Vehicle.
(iii) Explain the evaluation of EV performance using a drive cycle. Draw the SAE-1227 A driving cycle and explain.
(iv) Calculate the Ahr capacity of a Lead Acid battery pack comprises of 20 batteries each of 12V used for an EV for the following specifications : EV drive average power requirement : 185whr/ km and distance in kilometres to be travelled in a single charge = 100km.

(b) State the historical background of EV / HEVs technology in brief. Describe the current state of the art of EV / HEVs technology along with technology challenges associated it. 4

(c) What is Peukert capacity of a battery? What is its significance in EV applications? Calculate the Peukert capacity of a 135Ahr battery with C10 (10 hr) rating (Peukert Coefficient is 1.2) 4

2. (a) Compare and differentiate between the battery electric vehicle (BEV), hybrid EV (HEV) and Plug-in HEV (PHEV) technologies. 6

(b) Define the Hybridness (H) for a hybrid EV. Classify the HEV based on hybridness. 4

(c) Describe the power flow control in a Parallel Hybrid and Series Parallel Hybrid electric drivetrain topologies. 10

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3. (a) A DC-DC converter used in a two wheeler EV drive is fed from a battery pack of 36V produces output voltage $V_0 = 60V$ at output power $P_0 = 400W$. 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 $L = 3mH$, $r_L$ (resistance of L) $= 0.05\Omega$, $C = 470\mu F$ and $f_s = 20kHz$. **10**

(b) Calculate the net energy transferred in an ultra-capacitor (UC) of 100F used in an EV drive when the voltage applied across the UC is varied as follows : The potential difference is varied uniformly from 0 to 60 V in 10 seconds. It is then maintained at 60 V for 20 second, and then decreased uniformly to 24V, in 70 seconds. Plot a graph, showing the variation of current during the 100 seconds of operation, as described above. **6**

(c) Compare the characteristics and performance of batteries, and ultra - capacitors for an EV application. **4**

4. (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 modelling. **10**

(b) Describe the following in brief : **10**

(i) Use of renewable energy sources in EV / HEV / PHEV.

(ii) Hybridization of different energy sources for EV/ PHEV applications.

5. (a) For an induction motor to be used as EV drive, explain a typical power converter topology and control strategy which can be adopted for EV application. **10**

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

7. Write a short note on (**Any Three**) : **20**

(i) Electric motors used for EV and HEV drives

(ii) Energy management strategies used in EV / HEV / PHEV

(iii) Battery charging methods used in EV / PHEV

(iv) EV battery specifications and their significance in EV design.

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