Exam.Code:0937
Sub. Code: 6648

2123

B.E. (Electrical and Electronics Engineering)
Seventh Semester
PE-EE-702: Electrical and Hybrid Vehicles

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: ***Attempt five questions in all, including Question No. 1 which is compulsory and selecting two questions from each Part. Assume suitably missing data, if any.***

x-x-x

Q1.a. Relate the torque capacity of 2000 rpm (MP_{2000}) of the torque converter with capacity factor with appropriate expression. Also show the characteristics of this capacity factor on torque-ratio and speed-ratio. **(2)**

b. Write the various power-train components of a hybrid electric vehicle (*HEV*). **(2)**

c. Why *PEMFC* is preferred over *SOFC* in *HEVs*? **(2)**

d. Make the analogy between the governing equations for capacitor and flywheel. **(2)**

e. Draw the torque-speed characteristics of internal combustion engine (*ICE*) and electric machine. **(2)**

Part-A

Q2. Starting from the force equations acting on a hybrid vehicle, develop the amount of energy, E^{+}_{pwt} that the power train of this vehicle will develop during acceleration. **(10)**

Q3.a. Develop the second order mathematical model of the battery. **(5)**

b. Write short note on Switched reluctance motor. **(5)**

Q4.a. Develop the expressions for electromagnetic torque (*Te*), maximum torque (*Tem*) and the slip at which maximum torque occurs for a three-phase induction machine. Refer all the parameters on stator side while making this analysis. Draw the torque-speed characteristics of this machine in all its operating modes. **(4, 2, 1, 1)**

b. Also, draw the torque-speed characteristics of three-phase induction motor drive system which is relevant to internal combustion engine (*ICE*). **(2)**

Part-B

Q5.a. Develop the hybrid energy storage system for a electric vehicle having two separate *DC/DC* converters being fed by *PEMFC*, super-capacitor and a battery. **(3)**

Contd....P/2

This combination of energy storage systems and converters is feeding the three-phase *AC* machine. The overall system must support the regenerative braking mode of the machine.

b. Develop the control strategy for a hybrid fuel cell power system for a *HEV*. Explain the working of this control strategy through appropriate flow-chart representation. (7)

Q6. (10)

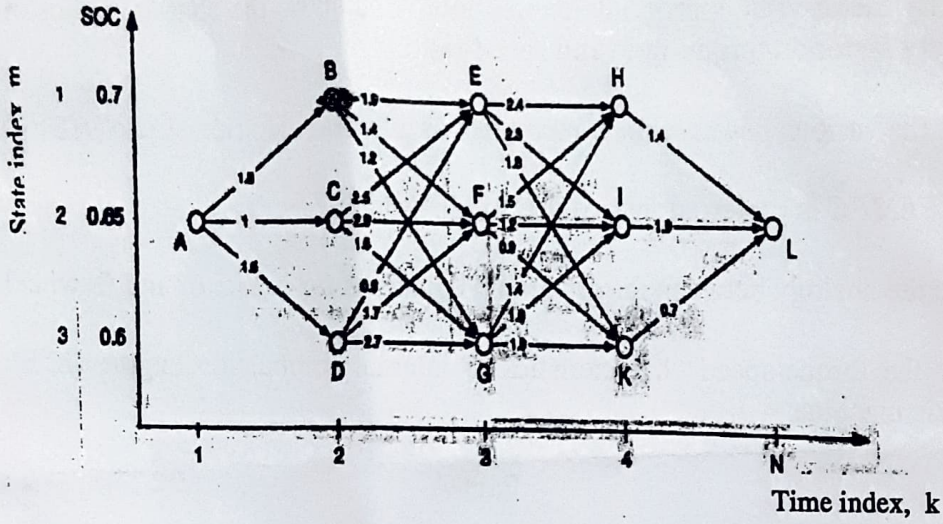

Figure-1

Figure 1 shows the possible arc-costs between state index, *SOC* and time index, *k* of a series *HEV* for moving from point *A* to *L*. Applying the dynamic programming this energy management problem, find out the cost-to-go $Y(x, k)$, optimal control matrix u^* and $u^*(x, k)$ of this vehicle.

Q7. Write short notes on:

a. PEMFC (5, 5)

b. Super-capacitor

x-x-x