Exam.Code:1018
Sub. Code: 35264

2056
M.E. Electrical Engineering (Power System)
Second Semester
EE-8205(b): Hybrid Electric Vehicles

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

NOTE: Attempt any <u>five</u> questions. Assume suitably missing data, if any.

x-x-x

Q1a. What are the various architectures of hybrid electric vehicles (HEV). Explain the various modes of parallel HEV in detail. *(5)*

b. Derive the expression for energy balance equation of a hybrid electric vehicle (HEV), starting from its equation of motion. *(5)*

Q2.a Draw the torque-speed characteristics of an internal combustion engine *(2)*

b. Develop the expression for speed of a brush-less direct current (BLDC) machine with the help of appropriate equivalent circuit and phasor diagram. *(6)*

c. Explain the structure of flywheel for smooth transition of motion? *(2)*

Q3. A 3-phase, 400V, 20 kW, 4-pole, 50 Hz, delta-connected induction motor being used in HEV has following per-phase parameters referred to stator: *(10)*

r_1=0.6 ohms, r_2=0.4 ohms, x_1=x_2=1.6 ohms.

Its magnetising reactance is neglected. If this motor is operated at 200 V, 25 Hz with direct-on-line starting. Calculate current and pf at the instant of starting and under maximum torque conditions. Compare the results with normal values.

Q4. A separately excited DC machine drive system is being fed from a 3-phase full-converter. What will be the average output voltage, V_o applied to armature circuit, rms value of source and thyristor current, I_{sr} and I_{Tr} and average value of thyristor current, I_{TA}? *(8,2)*

Also, draw the output voltage waveform, v_o for firing angle of 30^o.

P.T.O.

Q5. The various cost-to-go functions of a HEV from point A to L have been shown in figure-1. Find the optimal cost-to-go path using the dynamic programming along with cost-to-go matrix $Y(x,k)$, optimal control matrix $\mu^*(x, k)$ and corresponding input, u^*. *(10)*

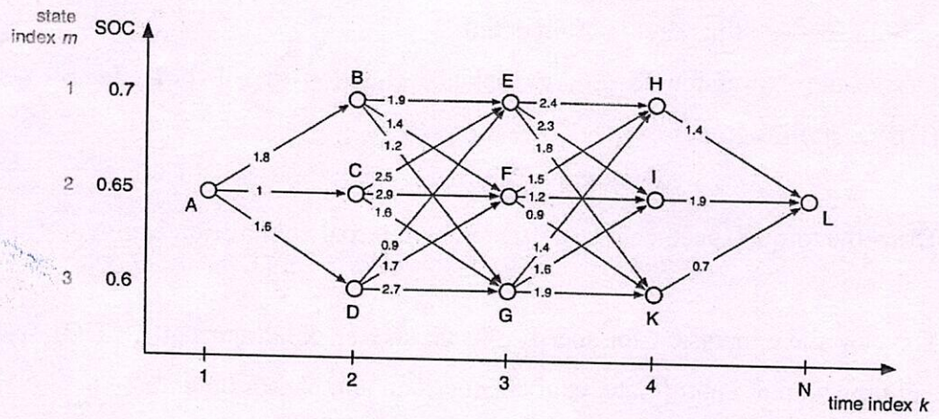

Figure-1

Q6a. Develop the equations for a *nth-order* battery model and hence draw its *second-order* equivalent circuit. Also, develop explicit expression of its current as a function of power. *(7)*

b. Write the expressions for load voltage, State-of-charge and capacitance, C of a super-capacitor. *(3)*

Q7a. Name and explain three terms related to vehicle performance. *(6)*

b. With the help of these terms, design the motor rating and fuel cell system of a electric vehicle taking a suitable example. *(4)*

Q8. Write short notes on: *(5,5)*

a. Integration of EVs in smart grid.

b. Connected and autononous mobility

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