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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Supplementary Examination August 2021

Course Code: EE469
Course Name: ELECTRIC AND HYBRID VEHICLES

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 5 marks. Marks

1 Explain the EV drivetrain alternatives based on drivetrain configuration. (5)

2 Compare electric and hybrid vehicles in terms of driving range, environmental impact, operating economy and drivetrain losses. (5)

3 Why induction motor drives are superior to DC motor drives for EV applications? (5)

4 Explain the basic working principle of lead acid batteries. (5)

5 In a pure electric vehicle, the battery power output is 45kW, and the efficiency of the transmission and drive motor is a total of 85%. If the maximum velocity of the vehicle is 10 m/s, what is the total tractive force the vehicle must develop in order to achieve this velocity? (5)

6 The traction motor in an EV is of output 80kW. Efficiency of the motor is 85%. (i).What should be the minimum power capacity of power converter to feed this drivetrain. (ii). If the power converter efficiency is 90%, what should be the minimum battery power? (5)

7 List the major functions of the control system in a HEV. (5)

8 What is the role of an energy management system in hybrid vehicles? (5)

PART B

Answer any two full questions, each carries 10 marks.

9 a) Explain the power flow control modes of a typical complex hybrid vehicle. (6)

b) What are the factors to be considered for the environmental impact analysis of hybrid vehicles? (4)

10 a) Explain the typical vehicle power plant characteristics for an ICE. What are its limitations? (6)

b) Describe the power flow control in a pure electric vehicle. (4)

11 a) What are the factors affecting the fuel efficiency of an electric vehicle? (4)

b) Write the expression for total resistive force on a vehicle, and explain the significance of each term. (6)

PART C

Answer any two full questions, each carries 10 marks.

12 a) Explain the forward motoring and regenerative (forward) braking control of a dc motor with a single chopper. Give circuit diagram, and show the quadrants of operation. (5)

b) Explain the basic working principle of lithium-ion batteries with the relevant chemical reactions. What are the advantages of this technology over lead-acid and Nickel based batteries? (5)

13 a) Give the block diagram of a hybrid electric vehicle highlighting the various electrical subsystems. Explain the functions of each subsystem (6)

b) What is meant by C – rating of a battery? If a 150Ah battery is rated C_{10}, what would be its discharge current expressed as $0.75C_{10}$? (4)

14 a) Explain the working principle of a Nickel-Metal Hydride battery with neat figures and relevant chemical reactions. Compare its major performance parameters with Lead-acid batteries. (6)

b) In v/f control of induction motors, explain how the torque-speed characteristics is modified over its entire speed range (including field-weakening mode). (4)

PART D

Answer any two full questions, each carries 10 marks.

15 a) A hybrid electric vehicle has two sources- an ICE with output power of 100kW and battery storage. The battery storage is a 100 Ah, C_{10} battery at 72V. (i). Calculate the battery energy capacity (ii). Without de-rating the Ahr capacity, what is the maximum power that can be supported by the battery. (iii). What is the electrical motor power output if the total efficiency of power converter and motor combination is 95%. (iv). What is the maximum power that can be transmitted to the wheels if the transmission efficiency is 90%? (5)

b) Explain the fuzzy rule base for different fuzzy inputs of engine speeds and acceleration pedal in order to generate the torque command in a hybrid vehicle. (5)

16 a) Draw the schematic block diagram representing a typical layout of Controller Area Network in a hybrid electric vehicle? What modification would you suggest for a pure electric vehicle? (6)

b) Explain the relation between hybrid-ness and regenerative braking capability. (4)

17 a) With the help of typical vehicle power plant characteristics, show that by increasing the number of gears gives a better approximation of the effective traction hyperbola. (5)

b) Explain state-machine based energy management scheme. (5)

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