CBCS SCHEME

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21AU52

Fifth Semester B.E. Degree Examination, June/July 2024
Fundamentals of Electric Vehicles

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. List out different green house gases and pollutants and briefly explain them (any five). **(10 Marks)**

b. Discuss the impact of NO_X on environment by the IC engine vehicles. **(10 Marks)**

OR

2 a. With a schematic diagram discuss a Battery Electric Vehicle (BEV) architecture and energy flow. Write an expression to determine the overall well-to-wheel efficiency. **(10 Marks)**

b. Sketch and explain the architecture and energy flow of a series – parallel, HEV. How do you calculate well-to-wheel efficiency of such a system? **(10 Marks)**

Module-2

3 a. Define the following terms along with the relations :
i) Power ii) Energy iii) Speed iv) Aerodynamic drag. **(08 Marks)**

b. An electric vehicle has the following attributes : drag coefficient $C_D = 0.25$, vehicle cross section $A = 2m^2$, available propulsion energy $E_r = 20KWh$, air density $\rho = 1.2kg/m^3$. Instantaneously at a vehicle speed of 120kmph, calculate the aerodynamic drag force, power, and range while driving in
i) calm condition with no wind
ii) windy conditions with 12kmph headwind. **(12 Marks)**

OR

4 a. With a schematic explain regenerative braking of the vehicle. **(07 Marks)**

b. Discuss how traction motor is characterized based on two modes of operation. **(08 Marks)**

c. A vehicle is travelling down a – 6° slope at 120kmph. Assuming calm conditions, how much regenerative power is available to brake the vehicle while maintaing a constant speed? The vehicle weighs 1645kg, with road-load power of 23.4KW. **(05 Marks)**

Module-3

5 a. Sketch and explain the working of a lead-acid battery. Write relevant chemical equation. **(10 Marks)**

b. Define the following battery parameters :
i) Beginning of Life (BoL)
ii) End of Life (EoL)
iii) Depth of Discharge (DoD)
iv) Capacity rate (c)
v) State of Charge (SoC). **(10 Marks)**

OR

6 a. Discuss various parameters affecting battery life. **(06 Marks)**

b. A 24KWh battery pack can be fast charged from 0% to 80% SoC in 30mins. Determine the approximate charge current and power in order to achieve this charge time. Assume nominal pact voltage as 360%. **(06 Marks)**

c. A battery has 96 cells in series per string with two parallel strings. Each cell has no-load voltage of 4.18V and an internal resistance of 2.8mΩ. Find :

i) pack current and voltage under a 80KW discharge if the battery is fully charged

ii) determine the discharge efficiency of the battery. Assume quadratic equation :

$R_{bp}I_{bp}^2 + P_{bp} - V_{bp(N)} \cdot I_{bp}$, where subscript bp stands for battery pack, R–resistance, P–power and I–current in A. **(08 Marks)**

Module-4

7 a. Elaborate briefly four quadrant operation of an electrical machine. **(10 Marks)**

b. Define the following terms : i) Rated torque ii) Rated and base speed iii) Rated power iv) Starting torque. **(10 Marks)**

OR

8 a. Describe characteristic curves of a machine in constant-torque and constant-power modes. **(10 Marks)**

b. The basic specifications of an electric machine are as follows :

i) Rated power, $P_{r\,rated}$ = 80KW ; Rated torque, $T_{r\,rated}$ = 280 Nm

ii) Gear ratio, n_g = 8.19 ; wheel raidus, r = 0.315m

Determine :

i) The rated speed of the rotor

ii) The frequency of the rotor and speed in rpm

iii) The speed of the axle

iv) The vehicle speed. **(10 Marks)**

Module-5

9 a. With a schematic sketch, example the working of a fuel cell. **(10 Marks)**

b. Briefly explain specific power density efficiency and power plant efficiency of a fuel cell. **(06 Marks)**

c. Determine the : i) Power density ii) Efficiency of fuel cell ii) Plant efficiency at full load if the balance of plant consumes 20% of fuel cell output power. Take V_{fc} = 0.621V at full load, No load reversible voltage, V_r° = 0.933V, current density, 15000A/m^2. **(04 Marks)**

OR

10 a. Briefly discuss how fuel cell plant sizing is done with reference to stack output voltage plant output, area, volume, energy and mass flow rate. **(10 Marks)**

b. A fuel cell power plant outputs 114KW and has 370 cells in series. The cell thickness is 1.34mm. The specific power density is 9315W/m^2, full load current density is 15000 A/m^2, and the plant consumes 20% of fuel cell output power. Determine :

i) The area of each cell

ii) The stack volume

iii) The mass flow rate of fuel

iv) The stack voltage

Take lower heating value (LHV) of hydrogen as 120MJ/kg and fuel cell efficiency of 66.56%. **(10 Marks)**

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