CBCS SCHEME

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18EE752

Seventh Semester B.E. Degree Examination, July/August 2022
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. Explain the following terms used in roadway fundamentals:
i) Roadway position vector
ii) Tangential roadway length
iii) Roadway percent grade. **(06 Marks)**

b. A straight roadway has a profile in $x_F - y_F$ plane given by, $f(x_F) = 3.9\sqrt{x_F}$ for $0 \le x_F \le 2$ miles, where x_F and y_F are given in feet.
i) Plot the roadway
ii) Find β (x_F)
iii) Find the percent grade at $x_F = 1$ mile. **(08 Marks)**

c. Define and derive the instantaneous tractive power delivered by the propulsion unit of the vehicle. Draw and explain the tractive power curve. Also derive the mean or average tractive power developed by the propulsion unit over the acceleration interval 0 to t_f. **(06 Marks)**

OR

2 a. An electric vehicle has the following parameter values. m = 800kg, $C_D = 0.2$, $A_F = 2.2m^2$, $C_O = 0.008$, $C_1 = 1.6 \times 10^{-6} s^2/m^2$. Also take density of air = $1.18kg/m^3$ and acceleration due to gravity $g = 9.81m/s^2$. The vehicle is on level road. It accelerates from 0 to 65mph in 10sec, such that its velocity profile is given by,
$V(t) = 0.29055t^2$ for $0 \le t \le 10sec$
i) Calculate $F_{TR}(t)$ for $0 \le t \le 10sec$
ii) Calculate $P_{TR}(t)$ for $0 \le t \le 10sec$
iii) Calculate the energy loss due to non-conservative forces.
iv) Calculate Δe_{TR}. **(10 Marks)**

b. Define road load force and describe its components with relevant equations. **(10 Marks)**

Module-2

3 a. State the advantages of electric vehicles over the IC engine vehicles. Also state the differences in infrastructure between IC Engine vehicles and electric vehicles. **(04 Marks)**

b. Explain the configuration of modern electric vehicle drive train with a neat functional diagram. **(08 Marks)**

c. Define series hybrid electric drive train and explain the configuration of it with a neat diagram by incorporating various operating modes in it. **(08 Marks)**

OR

4 a. Define speed ratio of traction motor in EV. Draw and explain the speed torque characteristics of a typical traction motor with different speed ratios. **(06 Marks)**

b. Define parallel hybrid electric drive train and explain the general configuration of it with a neat diagram by incorporating various operating modes in it. **(08 Marks)**

c. State and explain different types of mechanical coupling used in parallel hybrid electric drive training. **(06 Marks)**

Module-3

5 a. State various requirements for energy storage devices used in automotive applications. Explain the following terms:
   i) Specific energy
   ii) Specific power
   iii) Energy efficiency. **(08 Marks)**

   b. Explain the operating principle of lead acid battery with relevant chemical reaction equations. **(06 Marks)**

   c. Classify fuel cells into various types based on the type of electrolyte used. **(06 Marks)**

OR

6 a. Develop a fractional depletion model of batteries using two different approaches. **(08 Marks)**

   b. Explain about Lithium-ion battery technology with relevant chemical reaction equations and also state the advantages of it. **(08 Marks)**

   c. List out various parameters specified in battery by the manufacturers. **(04 Marks)**

Module-4

7 a. Explain the two-quadrant operation of chopper in the following schemes for the control of DC motors in electric vehicles.
   i) Single chopper with a reverse switch
   ii) Class-C two quadrant chopper. **(10 Marks)**

   b. Draw and explain the configurations of the following various inverter topologies used for SRM drive in Electric vehicles.
   i) Classic converter
   ii) R-dump inverter
   iii) C-dump inverter. **(10 Marks)**

OR

8 a. Explain the following control schemes used for a BLDC motor drive in EVs.
   i) Torque control scheme ii) Speed control scheme. **(06 Marks)**

   b. State the advantages and disadvantages of BLDC motor in electric vehicles. **(04 Marks)**

   c. Explain the constant V/f control applicable to induction motor drives for EVs. Also explain the power electronic control scheme for it with a neat block diagram. **(10 Marks)**

Module-5

9 a. Explain various operating patterns of a series hybrid electric drive train for its optimal operation. Also draw a typical series hybrid electric drive train configuration. **(10 Marks)**

   b. Explain various control strategies employed in a series hybrid electric drive train for vehicles with different mission requirements. **(10 Marks)**

OR

10 a. Explain the overall configuration of the parallel torque coupling hybrid drive train with a neat schematic diagram. **(06 Marks)**

   b. Explain the following control strategies employed in a parallel hybrid electric drive train:
   i) Max SOC-of-PPS control strategy.
   ii) Engine on-off control strategy.
   iii) Constrained engine on-off control strategy. **(14 Marks)**

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