Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

I SEMESTER M.TECH. (ELECTRIC VEHICLE TECHNOLOGY)

END SEMESTER EXAMINATIONS, NOVEMBER-DECEMBER 2023

SUBJECT: ELECTRIC VEHICLES [ELE 5117]

Time: 3 Hours **Date: 05 December 2023** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. Analyze Lithium-ion and Lead-acid batteries for electric vehicle applications. Discuss the advantages of fuel-cell electric vehicles. ***(04)***

1B. Interpret the necessary characteristics of induction motors and switch reluctance motors for electric vehicle applications. ***(04)***

1C. Determine the tractive effort needed for a 1240 kg vehicle to accelerate to 65 kmph in 9 seconds assuming constant acceleration. ***(02)***

2A. Estimate the total power required to overcome the forces opposing the EV propulsion on a flat road surface. Given that the length of the vehicle is 10 m, width is 3 m, height is 3.5 m, gross weight is 1800 kg, acceleration is 0.8 m/s^2, maximum speed is 45 km/hr. rolling resistance coefficient is 0.05, drag coefficient is 0.5, wind direction is aiding the vehicle movement, and wind velocity is 7 m/s. Also, design the battery pack rating to drive the vehicle for a minimum of 3 hours continuously. ***(04)***

2B. An electric vehicle is operated between a minimum and maximum speed limit. If the ratio of the required energy at the maximum and minimum speed to overcome the drag force is 1.8. Determine the maximum speed limit if the minimum speed of the vehicle is 30 kmph. Also, Compute the energy ratio, if the minimum and maximum speeds are 24 kmph and 49 kmph respectively. ***(02)***

2C. Components and efficiencies for a series hybrid electric vehicle are shown in Figure 1. Determine the driving range, miles per gallon value, and time to consume the energy in the gasoline tank by bypassing the battery. Consider the required parameters as specified in the table 1.

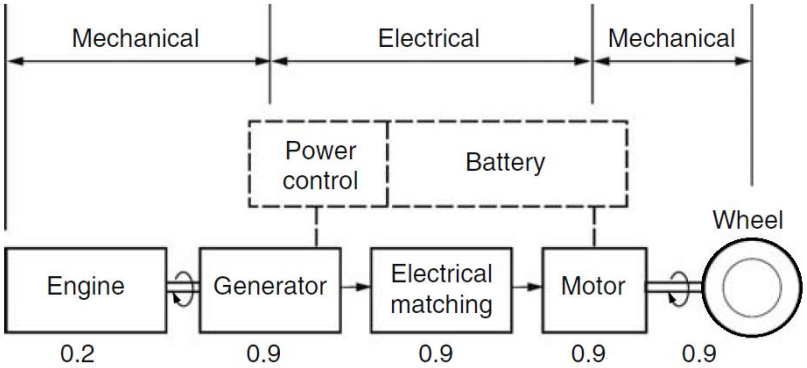

Figure 1: Series hybrid electric vehicle

Table 1: Parameter Specifications

Parameter	**Value**
Cruise Power	10 kW
Number of gallons of gas	15 gal
Energy density of gasoline	33.7 kWh/gal
Vehicle speed	70 kmph

(04)

3A. Analyze the significance of electric vehicle fleet on drive cycle. Compare the FTP75 urban and highway drive cycles for the electric vehicles with respect to the tractive effort and vehicle speed characteristics. ***(03)***

3B. Develop a closed-loop feedback control of a brushless DC motor drive of an electric vehicle considering a reference input of speed ω_{ref} incorporating Artificial Intelligence. ***(02)***

3C. The National Renewable Energy Laboratory (NREL) battery model is shown in Figure 2.

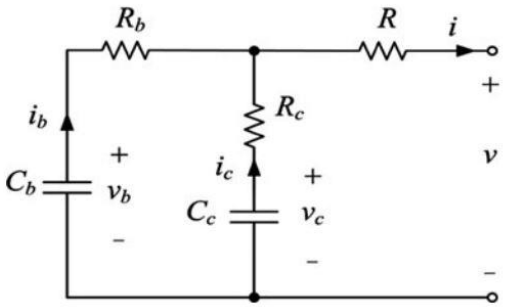

Figure 2: NREL battery model

Formulate the state space model for the battery considering that the voltage across the capacitors are the state variables. Also, discuss the importance of this model for electric vehicle applications. ***(05)***

4A. Interpret level 1, level 2, and level 3 charging systems for electric vehicles. Also, suggest a suitable charging level for domestic and commercial charging infrastructure. ***(03)***

4B. Illustrate the block diagram of on-board and off-board electric vehicle battery chargers. ***(02)***

4C. Identify the power quality issues associated with the following scenarios.

i. switching off a large load and improper scheduling of electric vehicles in V2G mode
ii. Energizing a capacitor bank
iii. Power system faults
iv. Equipment malfunctions and loose connections
v. Switching on a large load incorporating uncertain electric vehicle loads in G2V mode ***(05)***

5A. Suggest possible solutions to overcome the power quality issues due to the growing electric vehicles fleet. ***(03)***

5B. Model an objective function to manage mandatory loads and electric vehicle loads incorporating the necessary constraints. Assume EV load as a flexible load, step time is 60 minutes, and duration is 5 days. ***(02)***

5C. A three-phase bridge rectifier charges a 240V battery of an electric vehicle. The input voltage to the rectifier is three-phase, 230V, 50Hz supply. The current limiting resistance in series with battery is 7Ω and an inductor makes the load current almost ripple free. Determine the following.

i. Power delivered to the battery and load
ii. Input displacement factor
iii. Current distortion factor
iv. Input power factor
v. Input harmonic factor/Total harmonic distortion ***(05)***