Reg. No. : | | | | | | | | | | | | |

Question Paper Code:U2503

M.E. DEGREE EXAMINATION, APRIL / MAY 2025

Second Semester

Power Electronics and Drives

21PPE203- ELECTRIC VEHICLES AND ENERGY STORAGE

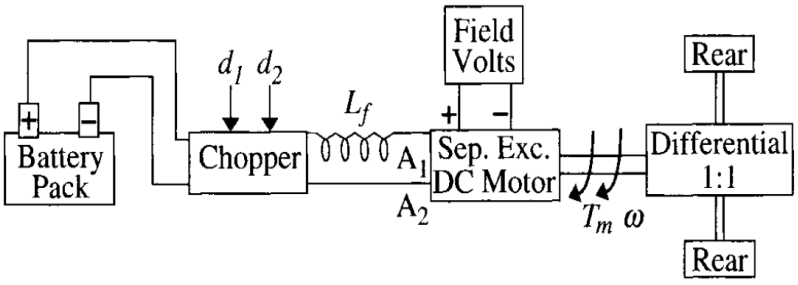
(Regulations 2021)

Duration: Three hours | Maximum: 100 Marks

Answer ALL Questions

PART – A (5 x 20 = 100 Marks)

1.	(a)	Explain need and importance of electric and hybrid vehicles.	CO1- U	(20)
		Or		
	(b)	What are the primary design characteristics and applications of electric vehicles?	CO1 - U	(20)
2.	(a)	Compare how lithium-ion batteries and hydrogen fuel cells work in electric vehicles. Which one is more efficient, and why?	CO4 - Ana	(20)
		Or		
	(b)	Investigate new technologies that could change how we store energy in electric vehicles. Evaluate their potential benefits and drawbacks.	CO4 - Ana	(20)
3.	(a)	An EV's drive train with a 72 V battery pack is shown in Figure below. The duty ratio for the acceleration operation is d_1 while the duty ratio for braking operation is d_2.	CO3 -App	(20)



The various parameters are given below:

EV parameters:

m=1000 kg, C_D=0.2, A_F=2 m^2,C_0=0.009, C_1=0, ρ=1.1614 $kg/m^3$and g=9.81 m/s^2,r_{wh}=radius of wheel=11 in=0.28 m

Motor and controller parameters:
Rated armature voltage V_{arated}=72 V
Rated armature current I_{arated}=400 A
R_a=0.5 Ohm, L_a=8 mH, K =0.7 V-s
fs=chopper switching frequency=400 Hz

(a) Find the series filter inductance L_f so that worst-case motor armature current ripple is 1% of I_{arated}.

(b) The vehicle road load characteristic on a level road is T_{TR}=24.7+0.0051 ω_{wh}^2. What is the EV steady state speed on a level road if d_1=0.7? Assume an overall gear ratio of one for the transmission system. Find the chopper mode of conduction.

(c) What is the percent ripple in the armature current for the operating point in (b)?

(d) The vehicle road load characteristic on a grade of 5.24% (β=3°) is TTR =119.1+0.0051 ω_{wh}^2.What is the EV steady state speed for d_1=0.7?

(e) What is the EV speed on grade of -5.24% using a brake pedal, with d_2 =0.5?

Or

(b) An electric vehicle has the following parameter values:m=800 kg, C_d=0.2, A_f=2.2 m^2, C_0=0.008, C_1=1.6*10- 6 s^2/m^2.Also, take density of air =1.18 kg/m^3, and acceleration due to gravity g=9.81 m/s^2.The vehicle is on level road. It accelerates from 0 to 65 mph in 10 s, such that its velocity profile is given by,$v(t)=0.29055\ t^2$ for $0 \le t \le 10$s — CO3 -App — (20)

(a) Calculate $F_{TR}(t)$ for $0 \le t \le 10$ s.

(b) Calculate $P_{TR}(t)$ for $0 \le t \le 10$ s.

(c) Calculate the energy loss due to non-conservative forces E_{loss}.

(d) Calculate Δe_{TR}.

4. (a) Assess the potential risks and uncertainties associated with energy storage systems for electric vehicles, including safety risks (e.g., thermal runaway, hydrogen leakage), supply chain risks (e.g., availability of critical materials, geopolitical tensions), and market risks (e.g., price volatility, regulatory changes). Evaluate the effectiveness of existing risk management strategies and mitigation measures, and propose recommendations for minimizing risks and enhancing resilience in the electric vehicle supply chain. — CO4 -Ana — (20)

Or

	(b)	Perform a techno-economic analysis of different energy storage systems for electric vehicles, considering factors such as initial capital costs, operating expenses, and total cost of ownership over the vehicle's lifespan. Compare the upfront costs, fuel/energy costs, maintenance requirements, and resale value of lithium-ion batteries versus hydrogen fuel cells, and assess how these economic considerations impact consumer adoption and market competitiveness of electric vehicles.	CO4 -Ana	(20)
5.	(a)	Case study of a General Motors (GM) EV	CO5 -Eva	(20)

Or

	(b)	Case Study: Braking Performance Analysis a) The case of locked front wheels and unlocked rear wheels b) The case of locked rear wheels and unlocked front wheels c) Braking process analysis Maximum available braking force on front wheels	CO5 -Eva	(20)