A **Reg. No. :** | | | | | | | | | | | | |

Question Paper Code: R3402

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2025

Professional Elective

R21EEV402 DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES

(Regulations R2021)

(Common to EEE and Biotech Engineering Branches)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. What is the primary source of propulsion in an electric vehicle? CO1- U

   (a) Gasoline (b) Diesel (c) Electric motor (d) Hydrogen fuel cell

2. Identify the main component that stores electrical energy in an electric vehicle. CO1- U

   (a) Radiator (b) Battery pack

   (c) Carburetor (d) Exhaust pipe

3. Show which one is used for torque control below rated speed. CO1- U

   (a) Voltage control b) Frequency control

   c) Field weakening d) Pulse-width modulation (PWM)

4. How torque changes in the constant power region of an electric vehicle motor as speed increases. CO1- U

   a) Torque increases b) Torque decreases

   c) Torque remains the same d) Torque fluctuates

5. Show what is used to represent the input–output relationship in a transfer function. CO2- U

   (a) Equation (b) Function (c) Model (d) Graph

6. Interpret the locations where the denominator of a transfer function equals zero. CO2-U

   (a) Zeros (b) Poles (c) Roots (d) Gains

7. Identify the component that primarily stores energy in a buck converter during power stage modeling. CO4- U

(a) Inductor (b) Capacitor (c) Resistor (d) Diode

8. The main purpose of the PWM block in a converter is to adjust the_____ CO4- U

(a) Frequency (b) Duty (c) Voltage D) Current

9. Identify the function that describes how load current variations influence output voltage in a buck-boost converter. CO6- U

(a) Response (b) Gain (c) Impedance (d) Feedback

10. What is used to Interpret the sensitivity of output voltage to duty ratio variations in a buck-boost converter? CO6- U

(a) Feedback (b) Gain (c) Impedance (d) Modulation

PART – B (5 x 2= 10 Marks)

11. Explain the importance of electric vehicles in modern transportation. CO1- U

12. Explain why Permanent Magnet Synchronous Motors (PMSM) are popular choices in EVs. CO2- U

13. Show how poles and zeros of a transfer function are determined. CO3- U

14. Show how averaging simplifies the analysis of power stage dynamics in PWM converters. CO5- U

15. Define and show the operation of Continuous Conduction Mode (CCM) in a buck-boost converter. CO6- U

PART – C (5 x 16= 80Marks)

16. (a) Demonstrate the mathematical representation of EV longitudinal dynamics and illustrate how rolling resistance, aerodynamic drag, gradient resistance, and acceleration terms collectively define the tractive effort. CO1 U (16)

Or

(b) Outline step-by-step method for calculating maximum speed, torque, and power of an EV considering vehicle mass, drag coefficient, and wheel radius. CO1- U (16)

17. (a) Model and compare the operational performance of DC motors and Induction motors in EV propulsion with respect to efficiency, torque density, and control schemes. CO1- U (16)

Or

	(b)	Explain the significance of Permanent Magnet Synchronous Motors (PMSM) in EV drives and utilize vector control and field-weakening methods for extending above-rated speed operation.	CO1- U	(16)
18.	(a)	With neat sketches, identify and model poles and zeros in the context of EV motor control systems.	CO2 App	(16)
		Or		
	(b)	Develop an analysis of the time response characteristics (rise time, settling time, overshoot) of an EV drive system.	CO2 App	(16)
19.	(a)	Apply the modelling steps of a PWM power stage with suitable EV examples.	CO4 App	(16)
		Or		
	(b)	Construct the average model of a buck converter and demonstrate its role in supplying EV auxiliary loads.	CO4 App	(16)
20.	(a)	Develop and utilize state-space equations for a buck–boost converter in CCM to derive the transfer functions for EV motor voltage control.	CO6 U	(16)
		Or		
	(b)	Plan and design a controller using Bode plot methods to stabilize an EV boost converter under wide load variations.	CO6 U	(16)