



CBCS SCHEME

21EE752

Seventh Semester B.E./B.Tech. Degree Examination, June/July 2026 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. What are the state variables used for modeling of vehicle kinetics and roadway? Provide the expression for these variables and explain with a neat diagram the model of vehicle kinetics and roadway. (06 Marks)
- b. An EV has the following parameters :
Air density (ρ) = 1.16 kg/m^3
Mass (m) = 692 kg
 $C_d = 0.2$
Frontal area (A_F) = 2 m^2
 $C_0 = 0.009$, $C_1 = 1.75 \times 10^{-6} \text{ s}^2/\text{m}^2$
Take acceleration due to gravity to be 9.81 m/s^2 .
The EV undergoes constant F_{TR} acceleration on a level road starting from rest at $t = 0$. The maximum continuous F_{TR} that the electric motor is capable of delivering to the wheels is 1548 N .
i) Find : V_T (F_{TR}) and plot it
ii) Consider now, for the case when $F_{TR} = 350 \text{ N}$, find V_T , t_{VT} , time required to accelerate from 0 to 60 mph, and P_{TRPK} corresponding to acceleration of $0.98 V_T$. (10 Marks)
- c. Explain the concept of maximum gradability of a vehicle. (04 Marks)

OR

- 2 a. Describe how Newton's second law of motion is applicable to a vehicle considering the forces to be acting on a single centre of gravity point. Describe how the expressions of the law change when a rotating rigid body is considered. (06 Marks)
- b. Assume the following constant parameters for an EV : Mass (m) = 676 kg , drag coefficient (C_D) = 0.21 , frontal area (A_F) = 1.98 m^2 , rolling resistance coefficient = 0.0086 , $C_1 = 1.67 \times 10^{-6} \text{ s}^2/\text{m}^2$, air density = 1.17 kg/m^3 , $g = 9.81 \text{ m/s}^2$.
i) The EV is stopped due to a traffic congestion. At this stop position, the grade is $+12\%$. The tractive force is supplied by the vehicle brakes. Compute the tractive force necessary for zero rolling resistance, and the minimum attractive force required from the brakes to keep the EV from rolling down the grade. Represent the forces using a vector diagram.
ii) The EV is moving at a constant velocity along a road that has a constant grade of -15% . Derive the expression for the road load force and its components in terms of velocity. (10 Marks)
- c. Define and explain :
i) Tractive force
ii) Road load force
Represent them using a vector diagram. (04 Marks)

Module-2

- 3 a. Explain the characteristics of a traction motor with appropriate curves. Also plot the power vs speed curve. (10 Marks)
- b. With neat block diagrams, explain the six possible configurations of EV due to the variation in electric propulsion characteristics and energy sources. (10 Marks)

OR

- 4 a. With a detailed diagram, explain the architecture and operating modes of a series hybrid electric vehicle. (10 Marks)
- b. Explain the various power flow routes in a hybrid electric vehicle considering IC engine system as the primary power train and battery as the secondary power train. (10 Marks)

Module-3

- 5 a. Explain in detail supercapacitors used in EVs and HEVs with its advantages and limitations. Also differentiate between supercapacitors and batteries used in EVs and HEVs. (10 Marks)
- b. With a neat sketch, explain the charging and discharging operations of a lithium-ion cell with relevant chemical equations. Mention its advantages and limitations. (10 Marks)

OR

- 6 a. List the various common types of fuel cells. With a neat diagram, describe the operation of a proton exchange membrane fuel cell and mention its advantages and limitations. (10 Marks)
- b. Describe the fractional depletion model (FDM) of a battery and explain with relevant equations how range prediction is done with
- i) Constant current discharge
 - ii) Power density approach. (10 Marks)

Module-4

- 7 a. With neat circuit diagrams, explain the operation of single – quadrant and two-quadrant choppers used to control the speed of DC motor used in EVs. Draw the speed –torque curves of a separately excited DC motor drive during motoring and regenerative braking. (10 Marks)
- b. Explain the power electronic circuit and its v/f (volts/hertz) control scheme employed to control an induction motor used in EVs. (10 Marks)

OR

- 8 a. Explain the typical propulsion system of EVs with a neat functional diagram. (10 Marks)
- b. Explain the torque control scheme of BLDC motors used in EVs. Mention the advantages and limitations of BLDC motor drives. (10 Marks)

Module-5

- 9 a. Explain the energy storage design of parallel hybrid drive train. (10 Marks)
- b. Explain the concept of power rating design of :
i) Traction motor
ii) Engine/generator
Specific to a series hybrid drive train. (10 Marks)

OR

- 10 a. Explain the various strategies of control used in a series hybrid drive train for vehicles with different mission requirements, with flowcharts. (10 Marks)
- b. Explain the overall control scheme of a parallel hybrid drive train with a neat diagram. (10 Marks)

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