

# **SRM VALLIAMMAI ENGINEERING COLLEGE**

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

## **DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

### **QUESTION BANK**



### **VI SEMESTER**

## **PEE403 - ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL**

**Regulation – 2023**

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*Prepared by*

**Dr. S. Padhmanabha Iyappan, Associate Professor/EEE**

**UNIT I - INTERNAL COMBUSTION ENGINES**

IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions.

**PART A**

<b>Q.No</b>	<b>Questions</b>	<b>CO</b>	<b>BT Level</b>	<b>Competence</b>
1.	Define an Internal Combustion engine.	1	BTL 1	Remembering
2.	List the main components of an IC engine.	1	BTL 1	Remembering
3.	Differentiate between SI and CI engines.	1	BTL 1	Remembering
4.	Define compression ratio.	1	BTL 1	Remembering
5.	What is engine displacement volume?	1	BTL 1	Remembering
6.	State the function of a carburetor.	1	BTL 1	Remembering
7.	Define Brake Mean Effective Pressure (BMEP).	1	BTL 2	Understanding
8.	Write the unit of BMEP.	1	BTL 2	Understanding
9.	Define Brake Specific Fuel Consumption (BSFC).	1	BTL 2	Understanding
10.	Write the unit of BSFC.	1	BTL 2	Understanding
11.	State the significance of BMEP in engine performance.	1	BTL 2	Understanding
12.	How does BSFC indicate engine efficiency?	1	BTL 1	Remembering
13.	Define vehicle fuel economy.	1	BTL 2	Understanding
14.	What is meant by mileage of a vehicle?	1	BTL 2	Understanding
15.	List any two factors affecting vehicle fuel economy.	1	BTL 2	Understanding
16.	State the importance of fuel economy in automobiles.	1	BTL 1	Remembering
17.	What are vehicle emissions?	1	BTL 1	Remembering
18.	List major exhaust emissions from IC engines.	1	BTL 2	Understanding
19.	What is the function of a catalytic converter?	1	BTL 2	Understanding
20.	Define emission norms.	1	BTL 2	Understanding
21.	What is diesel particulate matter (PM)?	1	BTL 1	Remembering
22.	Define NO <sub>x</sub> emissions.	1	BTL 2	Understanding
23.	What is Diesel Oxidation Catalyst (DOC)?	1	BTL 1	Remembering
24.	State the purpose of Diesel Particulate Filter (DPF).	1	BTL 1	Remembering

**PART B**

1.	Explain the working of a four-stroke diesel engine with a neat sketch.	(16)	1	BTL 3	Applying
2.	Calculate BSFC of an engine and explain its importance.	(16)	1	BTL 3	Applying
3.	Illustrate the use of BMEP for comparing engines of different sizes.	(16)	1	BTL 3	Applying
4.	Analyze the relationship between BMEP and torque.	(16)	1	BTL 4	Analyzing
5.	Explain factors affecting vehicle fuel economy.	(16)	1	BTL 3	Applying
6.	Describe the fuel economy differences between city and highway driving.	(16)	1	BTL 4	Analyzing
7.	Explain the working of a catalytic converter.	(16)	1	BTL 3	Applying
8.	Summarize the formation of exhaust emissions in IC engines.	(16)	1	BTL 4	Analysing
9.	Explain emission control techniques used in petrol engines.	(16)	1	BTL 3	Applying
10.	Analyse the causes of NOx formation in diesel engines.	(16)	1	BTL 4	Analysing
11.	Describe the operation of Diesel Oxidation Catalyst (DOC).	(16)	1	BTL 3	Applying
12.	Analyse the effectiveness of Diesel Particulate Filter (DPF).	(16)	1	BTL 4	Analysing
13.	Compare BSFC characteristics of petrol and diesel engines.	(16)	1	BTL 4	Analysing
14.	Explain the need for exhaust after-treatment systems.	(16)	1	BTL 3	Applying
15.	Analyse various diesel exhaust emission treatment methods.	(16)	1	BTL 4	Analysing
16.	Apply fuel economy concepts to reduce vehicle emissions.	(16)	1	BTL 3	Applying
17.	Examine the impact of BS-VI emission norms on diesel engines.	(16)	1	BTL 4	Analysing

## UNIT II - ELECTRIC VEHICLES AND VEHICLE MECHANICS

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics-Introduction to smart grid Technologies.

### PART A

Q.No	Questions	CO	BT Level	Competence
1.	Define an Electric Vehicle (EV).	2	BTL 1	Remembering
2.	List the main components of an Electric Vehicle.	2	BTL 1	Remembering
3.	Define Hybrid Electric Vehicle (HEV).	2	BTL 1	Remembering

4.	Differentiate between EV and HEV.	2	BTL 2	Understanding	
5.	What is meant by engine rating?	2	BTL 2	Understanding	
6.	State the unit of engine power.	2	BTL 1	Remembering	
7.	Define torque of an engine.	2	BTL 1	Remembering	
8.	What is meant by vehicle tractive effort?	2	BTL 1	Remembering	
9.	Define rolling resistance.	2	BTL 2	Understanding	
10.	What is aerodynamic drag?	2	BTL 1	Remembering	
11.	State the importance of vehicle mechanics.	2	BTL 1	Remembering	
12.	Define power-to-weight ratio.	2	BTL 2	Understanding	
13.	List any two advantages of Electric Vehicles.	2	BTL 2	Understanding	
14.	List any two disadvantages of Electric Vehicles.	2	BTL 2	Understanding	
15.	State two advantages of Hybrid Electric Vehicles.	2	BTL 2	Understanding	
16.	What is regenerative braking?	2	BTL 2	Understanding	
17.	Define smart grid.	2	BTL 2	Understanding	
18.	List components of a smart grid.	2	BTL 1	Remembering	
19.	What is vehicle-to-grid (V2G)?	2	BTL 2	Understanding	
20.	Define energy efficiency of a vehicle.	2	BTL 1	Remembering	
21.	State the need for smart grid in EV integration.	2	BTL 2	Understanding	
22.	What is battery capacity?	2	BTL 2	Understanding	
23.	Define state of charge (SOC).	2	BTL 1	Remembering	
24.	What is charging infrastructure?	2	BTL 1	Remembering	
<b>PART B</b>					
1.	Explain the working principle of an Electric Vehicle with a neat block diagram.	(16)	2	BTL 3	Applying
2.	Explain the configuration and operation of Hybrid Electric Vehicles (HEV).	(16)	2	BTL 4	Analyzing
3.	Compare Electric Vehicles with Internal Combustion Engine vehicles in terms of performance, efficiency, and emissions.	(16)	2	BTL 3	Applying
4.	Examine engine ratings such as power and torque and their effect on vehicle performance.	(16)	2	BTL 3	Applying

5.	Illustrate the forces acting on a moving vehicle using fundamentals of vehicle mechanics.	(16)	2	BTL 4	Analyzing
6.	Explain the tractive effort requirement for an Electric Vehicle.	(16)	2	BTL 4	Analyzing
7.	Explain the advantages and limitations of Electric Vehicles.	(16)	2	BTL 3	Applying
8.	Analyse the advantages of Hybrid Electric Vehicles over conventional vehicles.	(16)	2	BTL 3	Applying
9.	Discuss the energy consumption of Electric Vehicles under different driving conditions.	(16)	2	BTL 3	Applying
10.	Explain regenerative braking and analyse its impact on EV efficiency.	(16)	2	BTL 4	Analyzing
11.	Generalize the role of batteries in Electric Vehicle performance.	(16)	2	BTL 3	Applying
12.	Evaluate the charging methods used for Electric Vehicles.	(16)	2	BTL 4	Analyzing
13.	Describe the role of smart grid technologies in Electric Vehicle charging infrastructure.	(16)	2	BTL 4	Analyzing
14.	Analyse the impact of large-scale Electric Vehicle integration on the power grid.	(16)	2	BTL 4	Analyzing
15.	Analyse performance differences between EV, HEV, and ICE vehicles.	(16)	2	BTL 3	Applying
16.	Explain vehicle-to-grid (V2G) concept and analyse its benefits.	(16)	2	BTL 3	Applying
17.	Analyse future trends in Electric Vehicles and smart grid technologies.	(16)	2	BTL 4	Analyzing

### UNIT III - BATTERY MODELING, TYPES AND CHARGING

Batteries in Electric and Hybrid Vehicles - Battery Basics - Battery Parameters. Types- Lead Acid Battery - Nickel-Cadmium Battery - Nickel-Metal-Hydrate (NiMH) Battery - Li-Ion Battery - Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulphur Battery, Sodium-Metal-Chloride, Research and Development for Advanced Batteries. Battery Modeling, Electric Circuit Models. Battery Pack Management, Battery Charging.

#### PART A

Q.No	Questions	CO	BT Level	Competence
1.	Define battery.	3	BTL 1	Remembering

2.	State the role of batteries in Electric Vehicles.	3	BTL 2	Understanding	
3.	What is meant by battery capacity?	3	BTL 2	Understanding	
4.	Define state of charge (SOC).	3	BTL 1	Remembering	
5.	Define state of health (SOH).	3	BTL 1	Remembering	
6.	List any two battery parameters.	3	BTL 2	Understanding	
7.	What is a Lead Acid battery?	3	BTL 1	Remembering	
8.	State one advantage of Lead Acid batteries.	3	BTL 1	Remembering	
9.	What is a Nickel-Cadmium battery?	3	BTL 2	Understanding	
10.	Mention one application of Ni-Cd batteries.	3	BTL 2	Understanding	
11.	Define Nickel-Metal-Hydride (NiMH) battery.	3	BTL 2	Understanding	
12.	List one advantage of NiMH batteries.	3	BTL 1	Remembering	
13.	What is a Lithium-Ion battery?	3	BTL 1	Remembering	
14.	State one advantage of Lithium-Ion batteries.	3	BTL 1	Remembering	
15.	What is a Lithium-Polymer battery?	3	BTL 1	Remembering	
16.	Define Zinc-Air battery.	3	BTL 2	Understanding	
17.	What is Sodium-Sulphur battery?	3	BTL 2	Understanding	
18.	Define Sodium-Metal-Chloride battery.	3	BTL 2	Understanding	
19.	What is battery modeling?	3	BTL 2	Understanding	
20.	Define electric circuit model of a battery.	3	BTL 2	Understanding	
21.	What is battery pack management?	3	BTL 1	Remembering	
22.	Define Battery Management System (BMS).	3	BTL 1	Remembering	
23.	What is battery charging?	3	BTL 2	Understanding	
24.	List any one advanced battery technology under research.	3	BTL 1	Remembering	
<b>PART B</b>					
1.	Explain the construction and working of Lead Acid battery.	(16)	3	BTL 3	Applying
2.	Explain the working principle of Nickel-Cadmium battery.	(16)	3	BTL 4	Analyzing
3.	Explain the construction and working of Nickel-Metal-Hydride (NiMH) battery.	(16)	3	BTL 3	Applying
4.	Explain the construction and working of Lithium-Ion battery.	(16)	3	BTL 4	Analyzing
5.	Compare different types of batteries used in Electric Vehicles.	(16)	3	BTL 3	Applying

6.	Analyze the characteristics of Lithium-Ion batteries for EV applications.	(16)	3	BTL 3	Applying
7.	Explain Lithium-Polymer battery and its applications.	(16)	3	BTL 4	Analyzing
8.	Explain Zinc-Air battery and its advantages.	(16)	3	BTL 3	Applying
9.	Evaluate the working and applications of Sodium-Sulphur battery.	(16)	3	BTL 3	Applying
10.	Analyze the features of Sodium-Metal-Chloride battery.	(16)	3	BTL 4	Analyzing
11.	Explain battery modeling techniques used in Electric Vehicles.	(16)	3	BTL 4	Analyzing
12.	Examine the electric circuit models used for battery modeling.	(16)	3	BTL 3	Applying
13.	Explain battery pack configuration and management.	(16)	3	BTL 4	Analyzing
14.	Discuss the role of Battery Management System (BMS).	(16)	3	BTL 3	Applying
15.	Explain different battery charging methods used in EVs.	(16)	3	BTL 4	Analyzing
16.	Illustrate fast charging and its impact on battery life.	(16)	3	BTL 4	Analyzing
17.	Explain the recent research and development trends in advanced batteries.	(16)	3	BTL 3	Applying

#### UNIT IV - CONTROL PRELIMINARIES

Control Design Preliminaries - Introduction - Transfer Functions – Bode plot analysis for First order and second order systems - Stability - Transient Performance- Power transfer function for boost converter - Gain margin and Phase margin study-open loop mode.

##### PART A

Q.No	Questions	CO	BT Level	Competence
1.	Define control system.	4	BTL 1	Remembering
2.	What is meant by control design preliminaries?	4	BTL 2	Understanding
3.	Define transfer function.	4	BTL 1	Remembering
4.	State the assumptions made while deriving a transfer function.	4	BTL 1	Remembering
5.	What is an open-loop control system?	4	BTL 1	Remembering
6.	What is a closed-loop control system?	4	BTL 1	Remembering
7.	Define Bode plot.	4	BTL 1	Remembering

8.	What are the components of a Bode plot?	4	BTL 2	Understanding	
9.	Write the general transfer function of a first-order system.	4	BTL 2	Understanding	
10.	Mention one example of a first-order system.	4	BTL 2	Understanding	
11.	Write the standard transfer function of a second-order system.	4	BTL 1	Remembering	
12.	What is damping ratio?	4	BTL 1	Remembering	
13.	Define natural frequency.	4	BTL 1	Remembering	
14.	What is meant by system stability?	4	BTL 1	Remembering	
15.	List the types of stability in control systems.	4	BTL 2	Understanding	
16.	Define transient response.	4	BTL 1	Remembering	
17.	What are transient performance specifications?	4	BTL 2	Understanding	
18.	Define rise time.	4	BTL 1	Remembering	
19.	Define settling time.	4	BTL 2	Understanding	
20.	What is overshoot?	4	BTL 2	Understanding	
21.	Define gain margin.	4	BTL 2	Understanding	
22.	Define phase margin.	4	BTL 2	Understanding	
23.	What is meant by open-loop mode operation?	4	BTL 2	Understanding	
24.	State the application of a boost converter.	4	BTL 2	Understanding	
<b>PART B</b>					
1.	Derive the transfer function of a first-order control system and explain its characteristics.	(16)	4	BTL 4	Analyzing
2.	Analyze the Bode plot of a first-order system and explain magnitude and phase responses.	(16)	4	BTL 3	Applying
3.	Derive and explain the transfer function of a second-order system.	(16)	4	BTL 3	Applying
4.	Plot and Examine the Bode plot of a second-order system for different damping ratios.	(16)	4	BTL 3	Applying
5.	Explain the concept of stability and classify control systems based on stability.	(16)	4	BTL 3	Applying
6.	Analyze the transient response of a second-order system with suitable examples.	(16)	4	BTL 4	Analyzing

7.	Explain rise time, peak time, settling time, and overshoot with neat sketches.	(16)	4	BTL 3	Applying
8.	Discuss the effect of damping ratio on transient performance.	(16)	4	BTL 3	Applying
9.	Derive the power transfer function of a boost converter.	(16)	4	BTL 3	Applying
10.	Explain the operating principle of a boost converter with transfer characteristics.	(16)	4	BTL 4	Analyzing
11.	Analyze the stability of an open-loop system using Bode plot.	(16)	4	BTL 4	Analyzing
12.	Explain gain margin and phase margin with suitable frequency response plots.	(16)	4	BTL 3	Applying
13.	Determine gain margin and phase margin from a given Bode plot.	(16)	4	BTL 3	Applying
14.	Discuss the significance of gain margin and phase margin in control system design.	(16)	4	BTL 4	Analyzing
15.	Compare first-order and second-order systems based on transient response.	(16)	4	BTL 4	Analyzing
16.	Analyze an open-loop control system and comment on its stability.	(16)	4	BTL 4	Analyzing
17.	Explain control design preliminaries and their role in system analysis and design.	(16)	4	BTL 4	Analyzing

### UNIT V - CONTROL OF AC MACHINES

Introduction- Reference frame theory, basics-modeling of induction and synchronous machine in various frames-Vector control- Direct torque control.

#### PART A

Q.No	Questions	CO	BT Level	Competence
1.	Define reference frame theory in AC machine control.	5	BTL 1	Remembering
2.	State the need for reference frame transformation in AC machines.	5	BTL 1	Remembering
3.	Define stationary reference frame.	5	BTL 1	Remembering
4.	Define rotating reference frame.	5	BTL 1	Remembering

5.	What is meant by synchronous reference frame?	5	BTL 1	Remembering	
6.	Explain the advantage of d–q transformation.	5	BTL 1	Remembering	
7.	List the basic assumptions used in induction motor modeling.	5	BTL 1	Remembering	
8.	Define slip in an induction motor.	5	BTL 1	Remembering	
9.	What is space vector representation?	5	BTL 1	Remembering	
10.	List different reference frames used in AC machine modeling.	5	BTL 1	Remembering	
11.	Define vector control of AC machines.	5	BTL 1	Remembering	
12.	State the principle of field-oriented control (FOC).	5	BTL 1	Remembering	
13.	Identify the two components of stator current in vector control.	5	BTL 2	Understanding	
14.	What is torque-producing current component?	5	BTL 2	Understanding	
15.	What is flux-producing current component?	5	BTL 2	Understanding	
16.	State one advantage of vector control over scalar control.	5	BTL 2	Understanding	
17.	Define Direct Torque Control (DTC).	5	BTL 2	Understanding	
18.	What variables are directly controlled in DTC?	5	BTL 2	Understanding	
19.	Mention any two advantages of DTC.	5	BTL 2	Understanding	
20.	Mention any two disadvantages of DTC.	5	BTL 2	Understanding	
21.	What is the function of hysteresis controller in DTC?	5	BTL 2	Understanding	
22.	Define electromagnetic torque in AC machines.	5	BTL 2	Understanding	
23.	What is meant by decoupling control?	5	BTL 2	Understanding	
24.	Mention one industrial application of vector-controlled AC drives.	5	BTL 2	Understanding	
<b>PART B</b>					
1.	Explain reference frame theory and apply it to AC machine control.	(16)	5	BTL 3	Applying
2.	Derive the d–q axis model of an induction motor in stationary reference frame.	(16)	5	BTL 3	Applying
3.	Develop and analyse the mathematical model of an induction motor in synchronous reference frame.	(16)	5	BTL 4	Analyzing
4.	Explain the modeling of synchronous machine in different reference frames.	(16)	5	BTL 4	Analyzing

5.	Compare stationary, rotor, and synchronous reference frames with suitable diagrams.	(16)	5	BTL 4	Analyzing
6.	Explain the principle of vector control of induction motor with block diagram.	(16)	5	BTL 4	Analyzing
7.	Apply indirect vector control technique to an induction motor drive and explain its operation.	(16)	5	BTL 4	Analyzing
8.	Analyze direct vector control method used in AC drives.	(16)	5	BTL 4	Analyzing
9.	Explain torque and flux decoupling in vector-controlled drives.	(16)	5	BTL 3	Applying
10.	Explain field-oriented control (FOC) and its performance benefits.	(16)	5	BTL 3	Applying
11.	Explain the operating principle of Direct Torque Control (DTC) with block diagram.	(16)	5	BTL 4	Analyzing
12.	Describe the hysteresis-based torque and flux control in DTC.	(16)	5	BTL 3	Applying
13.	Compare vector control and DTC based on dynamic performance and complexity.	(16)	5	BTL 3	Applying
14.	Explain the switching table used in DTC and its role in torque control.	(16)	5	BTL 3	Applying
15.	Analyze the advantages and limitations of vector control techniques.	(16)	5	BTL 4	Analyzing
16.	Explain the dynamic response of AC drives under vector control operation.	(16)	5	BTL 3	Applying
17.	Explain (a) Space Vector Modulation (b) Flux estimation techniques in DTC.	(16)	5	BTL 4	Analyzing

### **COURSE OUTCOMES:**

Upon the successful completion of the course, students will be able to:

CO1. Describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles

CO2. Find gain margin & phase margin for various types of transfer functions of boost converter Analyze the operation of the n-pulse converters and evaluate the performance parameters

CO3. Demonstrate the Control of A.C. Machine.

CO4. Explain the concepts related with batteries and parameters of battery

CO5. Module the battery and to study the research and development for batteries