

SRM VALLIAMMAI ENGINEERING COLLEGE

(Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK



VII SEMESTER

PEE405 – Testing of Electrical Vehicles

Regulation – 2023

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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING QUESTION BANK

SUBJECT & SUBJECT CODE: PEE405 – TESTING OF ELECTRICAL VEHICLES

SEM / YEAR: VII / IV

UNIT I - EV STANDARDIZATION

Introduction - Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field – Standardization activities in countries like Japan. The International Electro Technical Commission - Standardization of Vehicle Components.

PART – A

Q.No	Questions	BT Level	Competence	CO
1.	Define EV standardization.	BTL-1	Understand	CO1
2.	Explain the importance of standardization in Electric Vehicles.	BTL-2	Remember	CO1
3.	Define interoperability in EVs.	BTL-1	Understand	CO1
4.	Describe the current status of EV standardization worldwide.	BTL-2	Remember	CO1
5.	Explain the role of standardization in ensuring EV safety.	BTL-2	Apply	CO1
6.	Name any two international organizations involved in EV standardization.	BTL-2	Understand	CO1
7.	List any two objectives of EV standardization.	BTL-1	Remember	CO1
8.	What is ISO?	BTL-3	Apply	CO1
9.	State the significance of communication standards in EVs?	BTL-4	Analyze	CO1
10.	Name two commonly used EV charging connector standards.	BTL-5	Evaluate	CO1
11.	What is CHAdeMO?	BTL-1	Remember	CO1
12.	What is a standardization body?	BTL-3	Apply	CO1
13.	Write the different types of standardization of EV components.	BTL-2	Understand	CO1
14.	Why are battery standards necessary?	BTL-2	Understand	CO1
15.	Define CCS.	BTL-5	Evaluate	CO1
16.	Enumerate the role of Japan in EV standardization?	BTL-1	Remember	CO1
17.	What is JISC?	BTL-6	Create	CO1
18.	What is the purpose of standardizing EV charging infrastructure?	BTL-1	Remember	CO1
19.	What is IEC 61851?	BTL-6	Create	CO1
20.	List out the features of IEC 62196?	BTL-4	Analyze	CO1

21	What is component standardization in EVs?	BTL-2	Understand	CO1
22	Why is motor standardization important in EVs?	BTL-4	Analyze	CO1
23	What is the purpose of EV testing standards?	BTL-2	Understand	CO1
24	How does standardization support global EV markets?	BTL-1	Remember	CO1
25	State the challenges in EV standardization.	BTL-2	Understand	CO1
PART – B				
1.	Explain the need for standardization in Electric Vehicles. Discuss its role in ensuring safety, interoperability, reliability, and market growth.	BTL-2	Understand	CO1
2.	Describe the current status of Electric Vehicle standardization worldwide.	BTL-1	Remember	CO1
3.	Explain the role of international standardization bodies active in EV development.	BTL-2	Apply	CO1
4.	Explain the concept of Electric Vehicle standardization and discuss its importance in the development of sustainable transportation systems.	BTL-2	Understand	CO1
5.	Describe the various areas of EV standardization, including batteries, charging systems, communication protocols, safety requirements, and vehicle components.	BTL-1	Evaluate	CO1
6.	Discuss the role of standardization in EV charging infrastructure. Discuss various charging standards used across the world.	BTL-4	Create	CO1
7.	Explain the objectives, structure, and functions of the International Electrotechnical Commission (IEC) in Electric Vehicle standardization.	BTL-2	Remember	CO1
8.	Discuss the major IEC standards related to Electric Vehicles and charging systems, such as IEC 61851 and IEC 62196.	BTL-2	Remember	CO1
9.	Analyse the importance of standardization of vehicle components in the global automotive industry with suitable examples.	BTL-4	Analyze	CO1
10.	Explain the role of international standardization bodies such as IEC, ISO, SAE, and IEEE in the development of EV standards.	BTL-1	Remember	CO1
11.	Describe the standardization activities carried out in Japan for Electric Vehicles and EV charging infrastructure.	BTL-1	Evaluate	CO1
12.	Explain the development and significance of the CHAdeMO charging standard in Japan.	BTL-2	Remember	CO1
13.	Analyse the importance of Electromagnetic Compatibility (EMC) in Electric Vehicles. Discuss the standards and testing procedures used to ensure EMC compliance.	BTL-4	Understand	CO1
14.	Analyse the sources of Electromagnetic Interference (EMI) in Electric Vehicles and explain the methods used to minimize EMI problems.	BTL-5	Apply	CO1

15	Describe the testing and certification procedures adopted to verify compliance with Electric Vehicle standards.	BTL-1	Analyze	CO1
16	Discuss the standardization requirements of EV batteries, including safety, performance, testing, transportation, and recycling standards.	BTL-2	Evaluate	CO1
17	Apply the testing and certification procedures to demonstrate how compliance with Electric Vehicle standards can be verified.	BTL-3	Remember	CO1
18	Discuss the challenges involved in achieving global standardization of Electric Vehicles and charging infrastructure.	BTL-5	Evaluate	CO1

UNIT II - TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES				
Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only). - Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer- Hybrid Electric Vehicles Tests (M and N category).				
PART – A				
Q.No	Questions	BT Level	Competence	CO
1.	What is the purpose of testing electric motors used in EVs?	BTL-1	Remember	CO2
2.	Why are controllers tested in electric vehicles?	BTL-1	Remember	CO2
3.	What is a Motor-Generator (M-G) set?	BTL-1	Remember	CO2
4.	What are the major test items in motor type testing?	BTL-2	Understand	CO2
5.	What is torque testing?	BTL-2	Understand	CO2
6.	Why is temperature rise testing important?	BTL-1	Remember	CO2
7.	What is insulation resistance testing?	BTL-4	Analyze	CO2
8.	What is overload testing?	BTL-3	Apply	CO2
9.	What is the principle of operation of an Eddy Current Dynamometer?	BTL-1	Remember	CO2
10.	Why is an Eddy Current Dynamometer used in EV testing?	BTL-4	Analyze	CO2
11.	What is regenerative testing in AC Dynamometers?	BTL-2	Understand	CO2
12.	What is speed control testing?	BTL-3	Apply	CO2
13.	What is torque-speed characteristic testing?	BTL-1	Remember	CO2
14.	What is the purpose of current measurement during testing?	BTL-6	Create	CO2
15.	What is endurance testing?	BTL-3	Apply	CO2
16.	What is acceleration testing in EV motors?	BTL-4	Analyze	CO2
17.	What are M and N-category vehicles?	BTL-5	Evaluate	CO2
18.	Why are hybrid electric vehicles tested separately?	BTL-5	Evaluate	CO2
19.	What is hybrid electric vehicle (HEV) testing?	BTL-6	Create	CO2
20.	What is the purpose of performance testing in HEVs?	BTL-5	Understand	CO2
21.	What is controller response time?	BTL-5	Evaluate	CO2
22.	What is the significance of discussion on test procedures?	BTL-6	Create	CO2
23.	Why is repeatability important in EV testing?	BTL-4	Analyze	CO2
24.	What is the main objective of motor and controller testing in EVs?	BTL-6	Create	CO2
25.	What is thermal testing of controllers?	BTL-1	Remember	CO2
PART – B				
1.	Explain about the Electric motor and controller for the test procedure for Electric Vehicle motors using a Motor-Generator (M-G) set.	BTL-3	Apply	CO2

2.	Analyse the motor test and controller test for the type test of Electric Vehicle motors.	BTL-4	Analyze	CO2
3.	Outline Test procedure of Electric Vehicle motors using a Motor-Generator (M-G) set.	BTL-1	Remember	CO2
4.	(i) Mention the limitations of M-G test and what strategy used for Eddy Current Type Engine Dynamometer to overcome it. (ii) Compare the test items of M-G test and Eddy Current Type Engine Dynamometer.	BTL-6	Create	CO2
5.	Describe the test procedure using an Eddy Current Type Engine Dynamometer.	BTL-3	Apply	CO2
6.	Discuss the test procedure for an Eddy Current Type Engine Dynamometer.	BTL-1	Remember	CO2
7.	(i) Mention the limitations of Eddy Current Type Engine Dynamometer and what strategy used for AC Dynamometer to overcome it with a neat block diagram of test setup. (ii) List the proposed standards.	BTL-2	Understand	CO2
8.	Describe the test procedure for AC Dynamometer.	BTL-2	Understand	CO2
9.	Explain the concept of hardware in the loop involved in the testing of electric motor/controller in vehicle environment with a neat block diagram.	BTL-5	Evaluate	CO2
10.	Summarize the test results of AC Dynamometer under variable gap operation.	BTL-4	Analyze	CO2
11.	Compare the test items of M-G test, Eddy Current Type Engine Dynamometer and AC Dynamometer.	BTL-1	Remember	CO2
12.	(i) Explain the comparison of gap command and measured gap. (ii) Review the comparison of Overall Efficiency.	BTL-4	Analyze	CO2
13.	(i) Enumerate the Application of test procedure of Motor-Generator (M-G) set. (ii) Mentions the merits of Eddy Current Type Engine Dynamometer test procedure	BTL-6	Create	CO2
14.	Compare the output power Test of M-G set and Eddy Current Type Engine Dynamometer.	BTL-5	Evaluate	CO2
15.	Compare the Temperature Rise Test of M-G set and Eddy Current Type Engine Dynamometer.	BTL-5	Evaluate	CO2
16.	Explain the testing methodology for Hybrid Electric Vehicles (HEVs) belonging to M-category vehicles.	BTL-4	Analyze	CO2
17.	Discuss the testing procedures and performance evaluation of Hybrid Electric Vehicles belonging to N-category vehicles.	BTL-6	Create	CO2
18.	Explain the complete testing procedures adopted for Electric Motors, Controllers, and Hybrid Electric Vehicles, highlighting the role of M-G Sets, Eddy Current Dynamometers, and AC Dynamometers.	BTL-3	Apply	CO2

UNIT III - FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC				
Functional safety life cycle - Fault tree analysis - Hazard and risk assessment – software development - Process models - Development assessments - Configuration management – Reliability. Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality – Standards - Safety Norms, Energy consumption and Power test- Functional safety of autonomous vehicles.				
PART – A				
Q.No	Questions	BT Level	Competence	CO
1.	What is Functional Safety?	BTL-1	Remember	CO3
2.	What is the objective of Functional Safety in Electric Vehicles?	BTL-4	Analyze	CO3
3.	What is a Functional Safety Life Cycle?	BTL-3	Apply	CO3
4.	Name the major phases of the Functional Safety Life Cycle.	BTL-4	Analyze	CO3
5.	What is Hazard Analysis and Risk Assessment (HARA)?	BTL-1	Remember	CO3
6.	What is ASIL?	BTL-1	Remember	CO3
7.	What is Fault Tree Analysis (FTA)?	BTL-1	Remember	CO3
8.	What is the purpose of Fault Tree Analysis?	BTL-2	Understand	CO3
9.	What is software development in Functional Safety?	BTL-3	Apply	CO3
10.	What is a Process Model? Name two software process models.	BTL-1	Remember	CO3
11.	What is Development Assessment?	BTL-2	Understand	CO3
12.	Why is Configuration Management important?	BTL-5	Evaluate	CO3
13.	Define Reliability.	BTL-4	Analyze	CO3
14.	What is a Reliability Block Diagram (RBD)?	BTL-2	Understand	CO3
15.	Define Redundancy.	BTL-6	Create	CO3
16.	What are the types of redundancy? Explain it.	BTL-5	Evaluate	CO3
17.	What is EMC?	BTL-2	Understand	CO3
18.	Why is EMC important in Electric Vehicles?	BTL-3	Apply	CO3
19.	What is Electromagnetic Interference (EMI)?	BTL-1	Remember	CO3
20.	Define Quality in automotive systems.	BTL-6	Create	CO3
21.	What is ISO 26262?	BTL-5	Evaluate	CO3
22.	What is Energy Consumption Testing in EVs?	BTL-2	Understand	CO3
23.	What is a Power Test?	BTL-3	Apply	CO3
24.	What is an Autonomous Vehicle? Why is Functional Safety important in Autonomous Vehicles?	BTL-1	Remember	CO3
25.	What are the major components of Autonomous Vehicle safety systems?	BTL-1	Remember	CO3
PART – B				
1.	Discuss the objectives, principles, and importance of Functional Safety in Electric and Hybrid Electric Vehicles.	BTL-3	Apply	CO3
2.	Explain the Functional Safety Life Cycle in detail with a neat diagram.	BTL-3	Apply	CO3

3.	Explain Hazard Analysis and Risk Assessment (HARA) and discuss its role in Functional Safety according to ISO 26262.	BTL-1	Remember	CO3
4.	Discuss Fault Tree Analysis (FTA) in detail with suitable examples related to Electric Vehicle systems.	BTL-2	Understand	CO3
5.	Explain the construction and analysis of a Fault Tree using AND and OR gates with a practical example.	BTL-2	Understand	CO3
6.	Explain Configuration Management in detail.	BTL-2	Understand	CO3
7.	Describe the V-Model for software development and explain its role in Functional Safety compliance.	BTL-1	Remember	CO3
8.	Explain Development Assessment and discuss the methods used to verify compliance with Functional Safety standards.	BTL-4	Analyze	CO3
9.	Describe different reliability measures such as Failure Rate, MTBF, Availability, and Reliability Function	BTL-4	Analyze	CO3
10.	Explain Reliability Block Diagrams (RBDs) and discuss their significance in Electric Vehicle reliability analysis.	BTL-1	Remember	CO3
11.	Explain the relationship between Functional Safety and Electromagnetic Compatibility (EMC) in Electric Vehicles.	BTL-1	Remember	CO3
12.	Discuss the major Functional Safety standards applicable to Electric Vehicles, with special reference to ISO 26262.	BTL-4	Analyze	CO3
13.	Explain EMC testing requirements and standards applicable to Electric Vehicles.	BTL-4	Analyze	CO3
14.	Discuss the sources of electromagnetic interference and their impact on Functional Safety.	BTL-6	Create	CO3
15.	Explain automotive safety norms and discuss their role in Electric Vehicle development and testing	BTL-4	Analyze	CO3
16.	Explain Energy Consumption measurement methods in detail.	BTL-4	Analyze	CO3
17.	Discuss Power Testing of Electric Vehicle motors and drive systems with suitable test procedures.	BTL-6	Create	CO3
18.	Discuss the Functional Safety requirements of Autonomous Vehicles and explain the challenges involved.	BTL-2	Understand	CO3

UNIT IV- EMC IN ELECTRIC VEHICLES				
Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DC-DC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements.				
Part-A				
Q.No	Questions	BT Level	Competence	COs
1	Define electromagnetic susceptibility.	BTL-1	Remember	CO4
2	What causes EMC problems in EVs?	BTL-1	Remember	CO4
3	Define electromagnetic immunity.	BTL-2	Understand	CO4
4	What are conducted emissions?	BTL-3	Apply	CO4
5	What are radiated emissions?	BTL-4	Analyze	CO4
6	What are conducted disturbances?	BTL-5	Evaluate	CO4
7	Differentiate between EMC and EMI.	BTL-1	Remember	CO4
8	Why are EVs more susceptible to EMC problems than conventional vehicles?	BTL-1	Remember	CO4
9	What is electromagnetic coupling?	BTL-2	Understand	CO4
10	What is common-mode current?	BTL-2	Understand	CO4
11	What is dv/dt in power electronic circuits?	BTL-3	Apply	CO4
12	Mention two EMC mitigation techniques for DC–DC converters.	BTL-4	Analyze	CO4
13	Why does wireless charging create EMC problems?	BTL-5	Evaluate	CO4
14	Mention one shielding technique used in wireless charging.	BTL-6	Create	CO4
15	What is a Vehicle Control Unit (VCU)?	BTL-1	Remember	CO4
16	Why is PCB layout important for EMC?	BTL-1	Remember	CO4
17	What is a Battery Management System (BMS)?	BTL-2	Understand	CO4
18	Mention two EMC protection methods used in BMS.	BTL-3	Apply	CO4
19	How does EMI affect voltage sensing in BMS?	BTL-4	Analyze	CO5
20	What is signal integrity?			
21	What is magnetic field leakage?	BTL-3	Apply	CO5
22	Why is EMC testing mandatory for Electric Vehicles?	BTL-4	Analyze	CO5
23	What is radiated immunity testing?	BTL-5	Evaluate	CO5
24	What is conducted immunity testing?	BTL-6	Create	CO5
25	Name any two international EMC standards applicable to Electric Vehicles.	BTL-2	Understand	CO4
Part-B				
1	Explain the concept of Electromagnetic Compatibility (EMC). Discuss its importance in Electric Vehicle design and testing.	BTL-1	Remember	CO5
2	Explain conducted emissions, radiated emissions, conducted immunity, and radiated immunity.	BTL-1	Remember	CO5
3	Discuss the major EMC problems encountered in Electric Vehicles and explain the methods used to minimize them.	BTL-2	Understand	CO5
4	Explain electromagnetic coupling mechanisms in Electric Vehicles and discuss suitable mitigation techniques.	BTL-3	Apply	CO5

5	Discuss the causes of common-mode and differential-mode noise in motor drives and explain suppression techniques.	BTL-4	Apply	CO5
6	Explain the EMC problems associated with inverter-fed motor drive systems used in Electric Vehicles.	BTL-5	Analyze	CO5
7	Explain the operation of DC–DC converters and discuss the EMC problems associated with their switching operation.	BTL-1	Remember	CO5
8	Discuss conducted and radiated emissions generated by DC–DC converters.	BTL-2	Understand	CO5
9	Explain the effects of switching transients in DC–DC converters and discuss techniques to minimize them.	BTL-4	Analyze	CO5
10	Explain the principle of wireless charging systems used in Electric Vehicles and discuss their EMC challenges.	BTL-1	Remember	CO5
11	Discuss electromagnetic field leakage in wireless charging systems and explain methods used for shielding and protection.	BTL-2	Understand	CO5
12	Discuss EMC issues associated with Vehicle Control Units (VCUs) and explain methods used to improve controller immunity.	BTL-3	Apply	CO5
13	Explain the importance of PCB layout, grounding, shielding, and signal integrity in vehicle controller EMC design.	BTL-4	Analyze	CO5
14	Describe the EMC design practices adopted in automotive electronic control units.	BTL-6	Create	CO5
15	Explain the Battery Management System (BMS) architecture and discuss EMC problems encountered in BMS operation.	BTL-3	Apply	CO5
16	Explain EMC protection techniques adopted in Battery Management Systems.	BTL-4	Analyze	CO5
17	Discuss the EMC requirements applicable to Electric Vehicles.	BTL-6	Create	CO4
18.	Explain the procedures adopted for conducted emission, radiated emission, conducted immunity, and radiated immunity testing.	BTL-5	Evaluate	CO4

UNIT V- EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM

Overview -EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High-Frequency, Equivalent Circuit of DC-DC Converter System, EMI Coupling Path.

Part-A

Q.No	Questions	BT Level	Competence	COs
1	Why is EMI a major concern in Electric Vehicles?	BTL-1	Remember	CO5
2	List the major sources of EMI in an EV powertrain.	BTL-2	Understand	CO5
3	What is an EV motor drive system?	BTL-3	Apply	CO5
4	What causes EMI in motor drive systems?	BTL-4	Analyze	CO5
5	Define switching transient.	BTL-1	Remember	CO5
6	Why are high di/dt values undesirable?	BTL-2	Understand	CO5
7	Why are high dv/dt values undesirable?	BTL-3	Apply	CO5
8	What is parasitic capacitance?	BTL-6	Create	CO5
9	What is current slew rate (di/dt)?	BTL-4	Analyze	CO5
10	What is conducted emission testing?	BTL-1	Remember	CO5
11	What is the frequency range normally considered for conducted emission tests?	BTL-2	Understand	CO5
12	What is LISN (Line Impedance Stabilization Network)?	BTL-4	Analyze	CO5
13	Why is LISN used in EMC testing?	BTL-1	Remember	CO5
14	Name two instruments used for conducted emission measurement.	BTL-2	Understand	CO5
15	Why is IGBT considered an EMI source?	BTL-3	Apply	CO5
16	What causes switching noise in an IGBT?	BTL-1	Remember	CO5
17	Mention two methods to reduce IGBT-generated EMI.	BTL-5	Evaluate	CO5
18	What is an EMI coupling path?	BTL-6	Create	CO5
19	Name the four major EMI coupling mechanisms.	BTL-1	Remember	CO5
20	Why is EMI modelling important?	BTL-5	Evaluate	CO5
21	What is the purpose of an equivalent circuit model?	BTL-5	Evaluate	CO5
22	What are the major EMI sources in a DC–DC converter?	BTL-6	Create	CO5
23	Why do DC–DC converters generate conducted EMI?	BTL-1	Remember	CO5
24	Define radiative coupling.	BTL-5	Evaluate	CO5
25	Mention two techniques used to reduce EMI in DC–DC converters.	BTL-2	Understand	CO5

Part-B

1	Explain the significance of Electromagnetic Interference (EMI) in Electric Vehicle power electronic systems.	BTL-1	Remember	CO5
2	Discuss the various sources of EMI in Electric Vehicles.	BTL-3	Apply	CO5
3	Explain the EMI generation mechanism in Electric Vehicle motor drive systems with neat diagrams.	BTL-6	Create	CO5

4	Explain the effects of voltage slew rate (dv/dt) and current slew rate (di/dt) on EMI generation in motor drives.	BTL-1	Remember	CO5
5	Discuss common-mode and differential-mode noise generation in motor drive systems.	BTL-3	Apply	CO5
6	Explain the influence of parasitic capacitances and stray inductances on EMI generation in motor drive systems.	BTL-2	Understand	CO5
7	Explain the conducted emission testing procedure for Electric Vehicle motor drive systems.	BTL-4	Analyze	CO5
8	Discuss the construction and operation of Line Impedance Stabilization Network (LISN) in conducted emission testing.	BTL-1	Remember	CO5
9	Explain the operation of an IGBT and discuss why it is considered the primary source of EMI in Electric Vehicle motor drives.	BTL-2	Understand	CO5
10	Discuss the major EMI sources in DC–DC converters and explain their effects on system performance.	BTL-6	Create	CO5
11	Describe the equivalent circuit model of a DC–DC converter system and explain its significance in EMI analysis.	BTL-2	Understand	CO5
12	Discuss EMI coupling paths in DC–DC converter systems and explain methods for minimizing interference.	BTL-4	Analyze	CO5
13	Explain computational methods used for EMI analysis and modelling in automotive power electronic systems.	BTL-1	Remember	CO5
14	Discuss the importance of EMI modelling in predicting and reducing electromagnetic interference in Electric Vehicle systems.	BTL-4	Analyze	CO5
15	Discuss the causes of EMI in inverter-fed motor drives and explain the role of high-frequency switching.	BTL-4	Analyze	CO5
16	Explain the EMI generation mechanism in Electric Vehicle motor drive systems with neat diagrams.	BTL-1	Remember	CO5
17	Explain various techniques used to reduce EMI generated by IGBT-based inverters.	BTL-4	Analyze	CO5
18	Explain the conducted high-frequency emissions produced by DC–DC converters	BTL-5	Analyze	CO5

Course Outcome

CO1: Describe the status and other details of standardization of EVs.

CO2: Illustrate the testing protocols for EVs and HEV components.

CO3: Analyze the safety cycle and need for functions safety for EVs.

CO4: Analyze the problems related with EMC for EV components.

CO5: Evaluate the EMI in motor drive and DC-DC converter system.