PRACTICAL NO: 1

Date : 6/01/25

TITLE : To study and analyze the performance of series hybrid configuration.

AIM / OBJECTIVE: 1) Different components of series hybrid configuration.
2) Energy flow and Modes of operator.
3) Pro's and con's and application.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

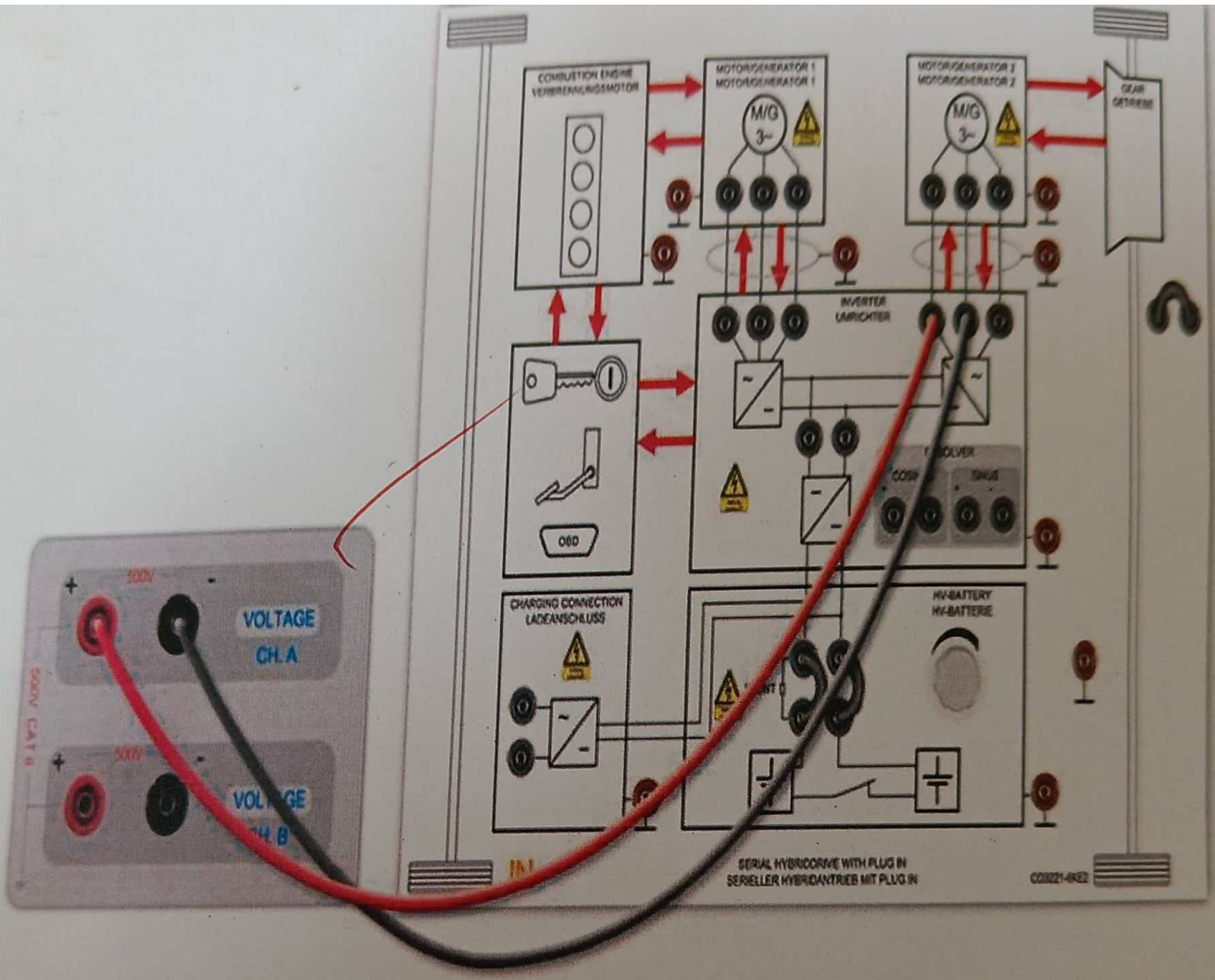
CO3221-6KE2 (Serial hybrid drive plug in) Car Train setup, Connecting wire, LAN.
Jumpers
Virtual oscilloscope.

CONCEPT / THEORY OF EXPERIMENT:

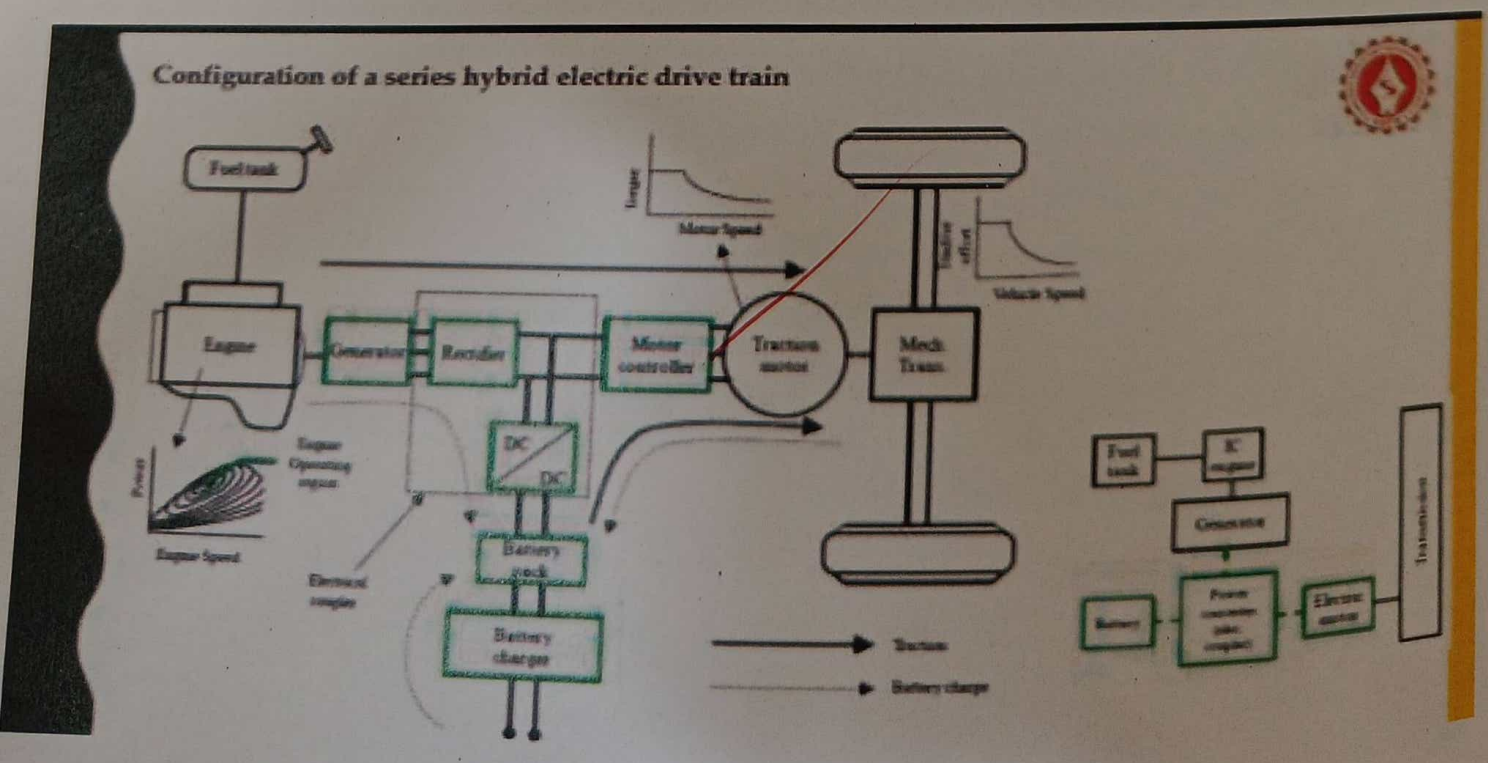
A series hybrid system is a type of vehicle power-train where the internal combustion engine is used solely to generate electricity instead of directly driving the wheels. The electricity stored is either stored in a battery or sent directly to an electric motor that drives the wheels. This design ensured the ICE operates at it's most efficient speed resulting in better fuel economy and lower emission.

PROCEDURE :

1) Turn on the main switch.
2) Use overlay CO3221-6KE2 and move the ignition key from setting 0 to 1.
3) The energy flow view can be enlarged by touching the cockpit display.
4) Set the high voltage battery percentage as per requirement using knob provided.
5) Observe the energy flow at different speeds.
6) Analyze the energy flow scheme.



Configuration of a series hybrid electric drive train



*Configuration of Series Hybrid Systems *

Series Hybrid systems can be designed in different config based on efficiency and power needs.

1) Pure Series Hybrid :- The ICE only acts as a generator and never directly drives the wheels.

2) Series Parallel Hybrid :- A combination of series and parallel hybrid modes, where the ICE can drive the wheels directly if needed (eg :- Toyota Hybrid Synergy drive).

3) Range - Extended Electric Vehicle (REEV) :- The primary power source is battery and the ICE acts as a backup generator for extended range (eg. Chevrolet Volt).

*Different Components and Concepts of Series Hybrid *

→ A series hybrid vehicle has a drivetrain where the internal combustion engine (ICE) is not directly connected to the wheels instead, it works as a generator to charge the battery or power the electric motor, which drives the wheels.

Key Components :-

1) Internal Combustion Engine (ICE) :- Acts as a generator to produce electricity.

2) Electric Generator :- Converts mechanical energy from the ICE into electrical energy.

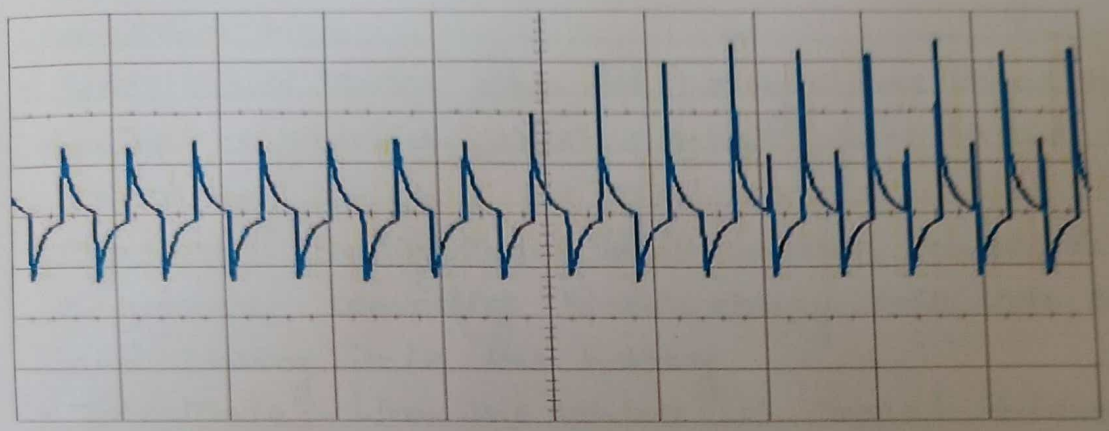
3) Battery Pack :- Stores electrical energy for use by the electric motor.

4) Electric Motor :- Drives the wheels directly.

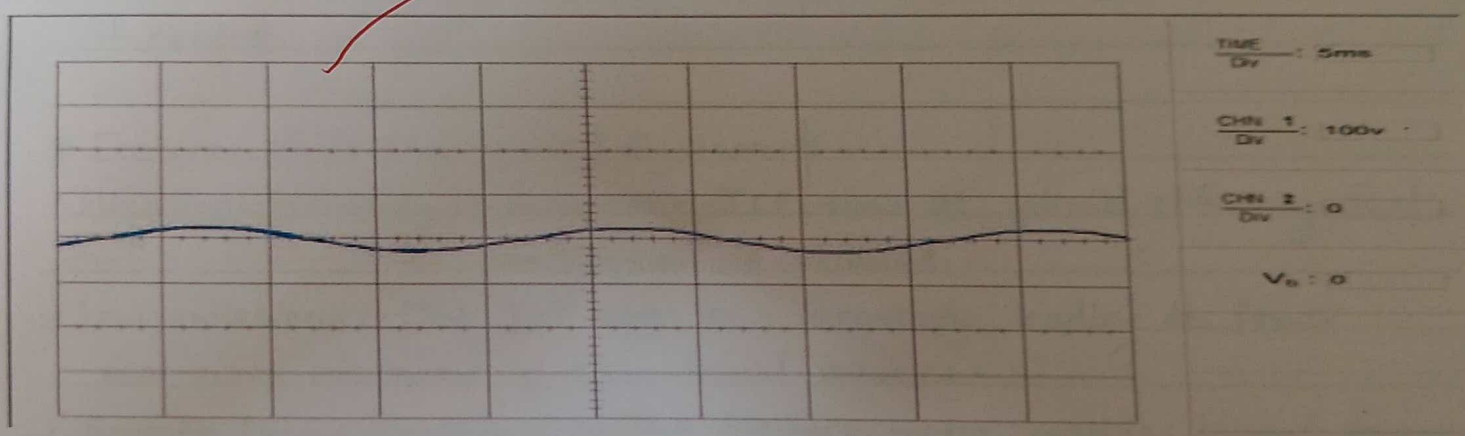
5) Power Control Unit : Manages the energy flow between the generator, battery and motor.

OBSERVATIONS

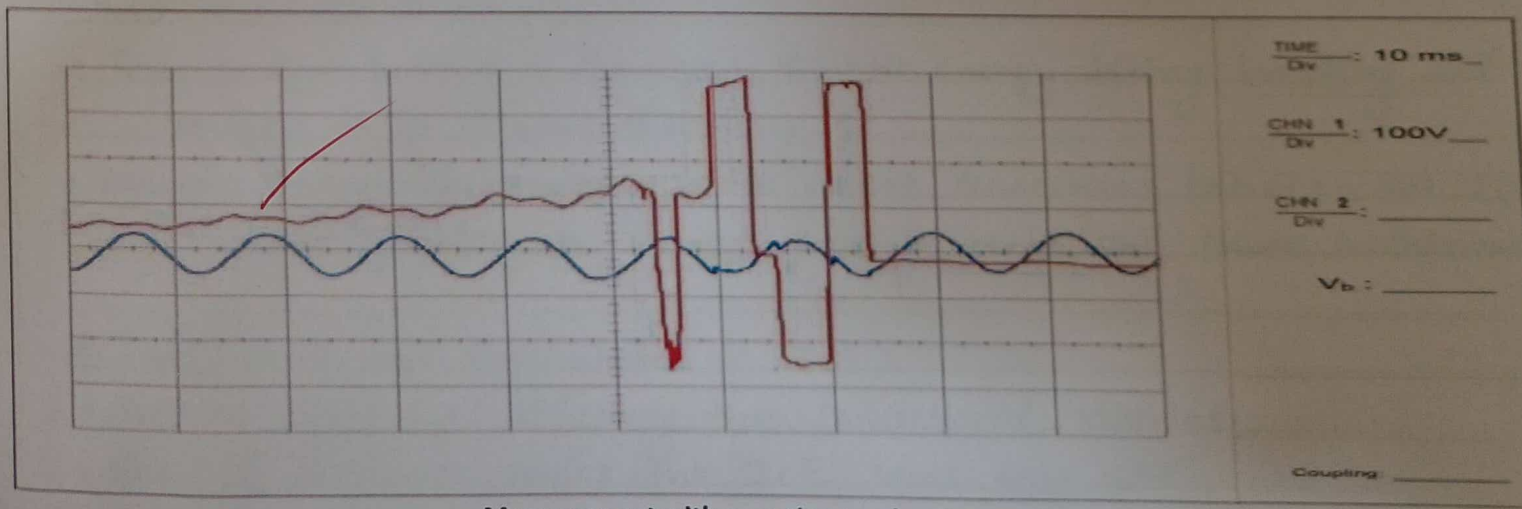
Prasad Kadam
TY – MTRX
A2
PRN : 2200601081



Measurement: Electric driving mode



Measurement: Energy recovery



Measurement with an active combustion engine

- Lower maintenance costs as the ICE runs less frequently.

OBSERVATIONS

* Energy Flow and Modes of Operations *

A series hybrid vehicle operates in different modes based on driving conditions.

- Battery Mode (EV mode) :- The electric motor is powered directly by the battery, and the ICE remains off. Used during low speed driving or short trips.
- Series Hybrid Mode :- When the battery charge drops the ICE starts running the generator, which supplies power to the motor or recharges the battery.
- Regenerative Braking Mode :- While braking, the electric motor acts as a generator, converting kinetic energy back into electrical energy and storing it in the battery.
- Idle Mode :- When the vehicle is stopped ~~it in the battery~~ the ICE turns off to save fuel, and the power is drawn from the battery if needed.

* Features of Series Hybrid System *

- High Fuel Efficiency :- Since the ICE runs at optimal efficiency, fuel consumption is reduced.
- Low emissions :- The ICE runs less frequently, leading to fewer emissions compared to conventional vehicles.
- Smooth Driving Experience :- The Electric motor provides instant torque and seamless acceleration.
- Regenerative Braking :- Captures kinetic energy during breaking and reuses it to improve efficiency.
- Reduces Mechanical Complexity :- No direct connections between the ICE and wheels, leading to fewer moving parts and lower maintenance.

* Pros, Cons and Applications *

- Pros :- Higher fuel efficiency than conventional vehicles.
- Reduced emissions since the ICE runs only when necessary.
- Smooth driving experience due to electric motor propulsion.
- Lower maintenance costs as the ICE runs less frequently.

CALCULATIONS :

Con's :- Heavier due to the addition of batteries and electric components.
- Higher initial cost compared to conventional vehicles.
- Limited battery range, requiring ICE assistance for long-distance travel.

* Applications :- i) Hybrid Electric Vehicles (HEV's) : used in cars like chevrolet volt and nissan e-Power vehicles.
- Urban Transit Buses :- Efficient in stop-and-go traffic conditions.
- Military and Industrial Vehicles :- where fuel efficiency and power reliability are crucial.

* Specifications *
- Electric Generator :- Power rating 20-100 KW (Depending on Application).
- Type : Permanent magnet synchronous generator (PMSG) / Induction generator.
- Voltage Output :- Typically 300V-600V DC.
- Battery Pack :- Type
  Lithium-Ion (Li-ion) / Nickel-Metal Hydride ($NiMH$).
- Capacity :- 10-50 kwh (depends on range and vehicle size).

RESULTS :

- Voltage Range :- 300V-800V.
- Charging time :- Fast charging :- 30-60 mins (DC fast charging).
  Standard charging :- 4-8 hours (AC home charger).
- Life cycle :- 1000-3000 charge cycle.

CONCLUSION :

Hence, we studied the various parameters and operating modes related to series hybride configuration of HEV's.

PRACTICAL NO: 2

Date : 17/01/25

TITLE : To study, analysis of the performance of Paralled Hybrid.

AIM / OBJECTIVE: 1) Different components of parallel Hybrid configuration & concepts.
2) Energy flow, modes of operation.
3) Pro's & con's and applications.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

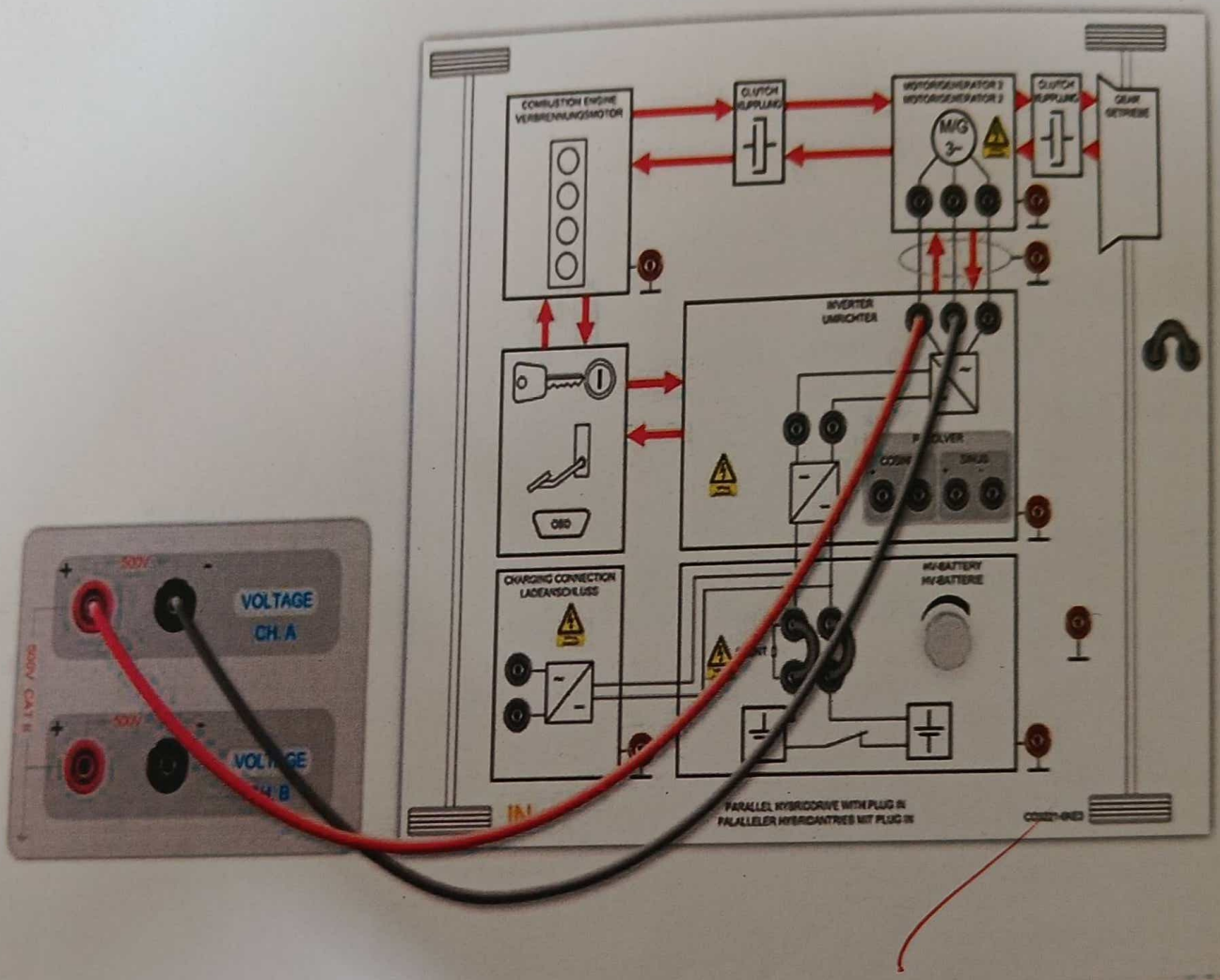
HEV LN setup
LN labsoft
PC
Multimeter.

CONCEPT / THEORY OF EXPERIMENT:

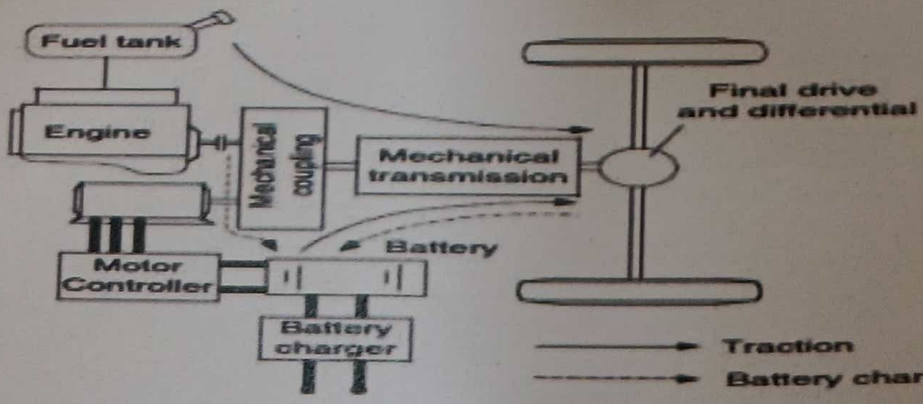
The paralled HEV allows both ICE & EM to deliver power to drive the wheels since both the ICE & EM are coupled to the driver shaft of the wheels via two clutches, the propulsion power may be supplied by ICE alone.

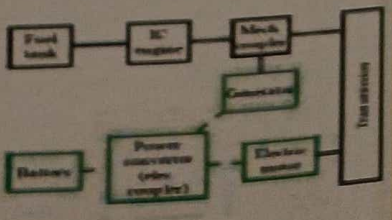
PROCEDURE :

1) Turn on the system.
2) Use overlay C03021-6KE2 & move the ignition key from setting 0 to 1.
3) The energy flow view can be enlarged by touching the cockpit display.
4) Set the high voltage battery % as per requirement.
5) Observe the energy flow at different speeds.
6) Analyse the energy flow scheme.



Configuration of a parallel hybrid electric drive train





Parallel Hybrid Drive

* Configuration of Parallel Hybrid System *

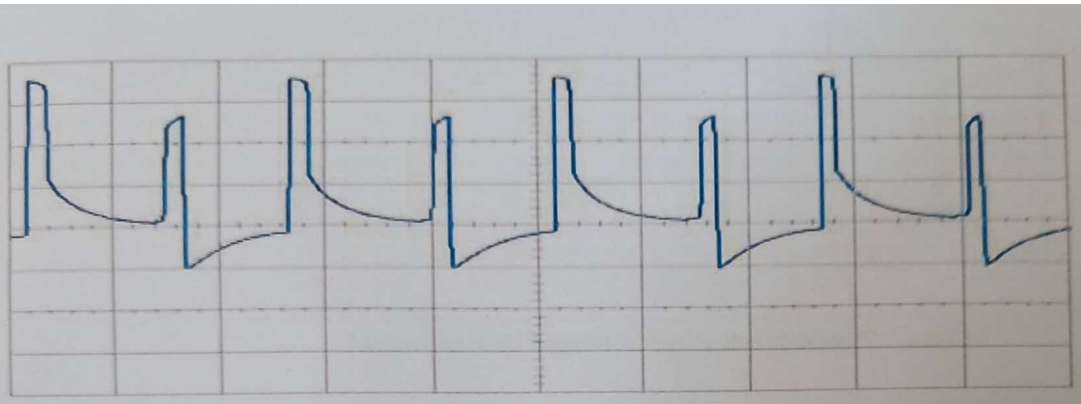
- Single Motor Parallel Hybrid :- One Electric motor assists the ICE and handles regenerative braking.
- Dual Motor Parallel Hybrid :- One Motor assists the ICE, while another handles regenerative braking and energy management.
- Plug-in Parallel Hybrid (PHEV) :- Larger battery capacity allows, external charging for extended EV range.
- Mild Hybrid (MHEV) : A small electric motor (48 V system) provides minor assistance, mainly for start-stop functions.

* Different Components and Concepts of Parallel Hybrid *

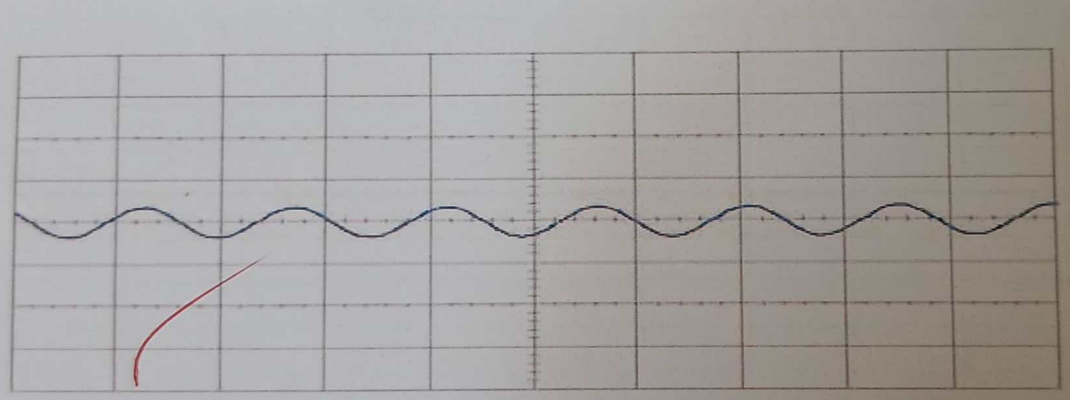
- A parallel hybrid vehicle has a drivetrain where both the internal combustion engine (ICE) and the electric motor can directly drive the wheels. This allows the vehicle to operate ~~directly drive the w~~ using the ICE alone, electric motor alone, or a combination of both.

* Key Components *

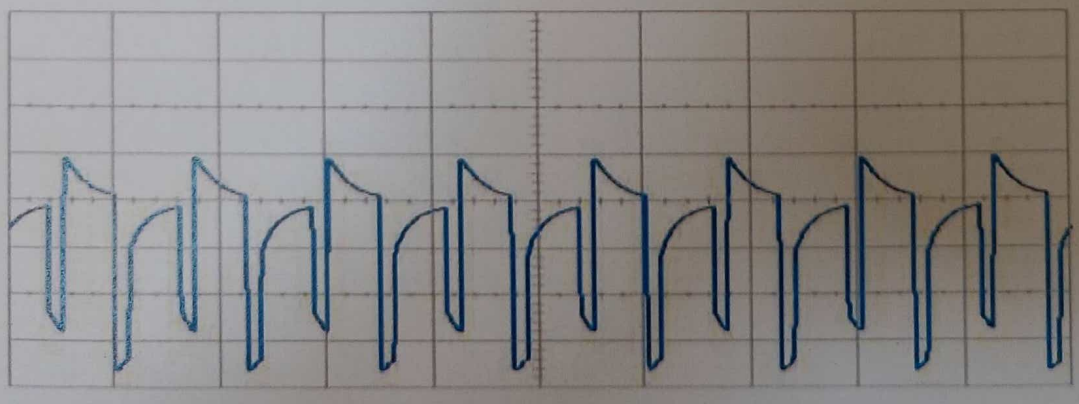
- Internal Combustion Engine (ICE) : Main power source, Connected to drivetrain.
- Electric Motor :- Assist the ICE or drive the vehicle independently.
- Battery Pack :- Stores electric energy for the motor.
- Transmission System :- Integrates both power sources (Common types : CVT, Automated Manual, or Dual-clutch).
- Power Control Unit (PCU) : Manages power distribution between the ICE, battery and motor.
- Regenerative Braking System :- Converts Braking energy into electrical energy and recharges the Battery.



Measurement : Boosting



Measurement: Electric driving mode



Measurement: Energy recovery

OBSERVATIONS

* Energy Flow and Modes of Operation *

- HEV mode (Low-speed Driving) :- Both the ICE and electric motor work together for higher power output. (Hybrid mode).
- EV mode (Hybrid Mode) (Acceleration / High load) : The vehicle runs on battery power, and the ICE remains off.
- ICE Mode (High-speed Cruising) :- The ICE directly drives the wheels for maximum efficiency.
- Regenerative Braking Mode :- The motor captures braking energy and converts it into battery power.
- Idle Stop Mode :- The engine turns off when the car is stopped (eg. at a traffic light).

* Features of Parallel Hybrid System *

- Higher Fuel Efficiency :- optimized power-sharing between the ICE & motor.
- Lower Emissions :- Reduces fuel consumption & CO_2 output.
- Better Performance :- offers a balance between power and efficiency.
- No Range Anxiety :- Since the ICE is always available for long distance travel.
- Regenerative Braking :- Enhance battery life and energy efficiency.
- Fast Refueling :- Unlike fuel electric vehicles, hybrids do not require charging downtime.

* Pro's, Con's and Applications *

Pros :-

- Higher efficiency due to both power source working together.
- Better acceleration & performance than series hybrid.
- Lower emissions compared to pure ICE vehicles.
- More reliable than battery-electric vehicles (BEVs) due to ICE backup.
- More affordable than fully electric car.

CALCULATIONS :

Con's :-

- Less fuel-efficient than series hybrid at low speed,
- More mechanical complexity than series hybrids.
- Battery capacity is smaller compared to full EV's.

Applications :-

- Passenger cars :- Toyota Prius, Honda Accord Hybrid, Hyundai Sonata,
- Sports Hybrids :- Acura NSX, BMW i8, Ferrari SF90.
- SUVs :- Ford Escape Hybrid, lexus Rx Hybrid.

Specifications :-

- Electric motor :- Power output :- 120-150 kW.
- Torque :- 100-400 Nm.
- Efficiency :- 90-95 %.

RESULTS :

Battery Pack :- Types : lithium (Li-ion / Nickel-Metal (NiMH).

- Capacity :- 1-20 kWh (varies with hybrid type).
- Voltage :- 200V-400 V.
- Charging :- Regenerative braking or external charging (for PHEV's only).

CONCLUSION :

Hence, we studied the various parameters & operating modes related to parallel hybrid configuration of HEV's.

PRACTICAL NO: 3

Date : 24/01/25

TITLE : To study and Analyze the performance of series and paralled Hybrid configuration.

AIM / OBJECTIVE: 1) Different components of serial-parallel Hybrid configuration and concepts.
2) Examine Energy Flow & modes of operations.
3) Pros & cons of application.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

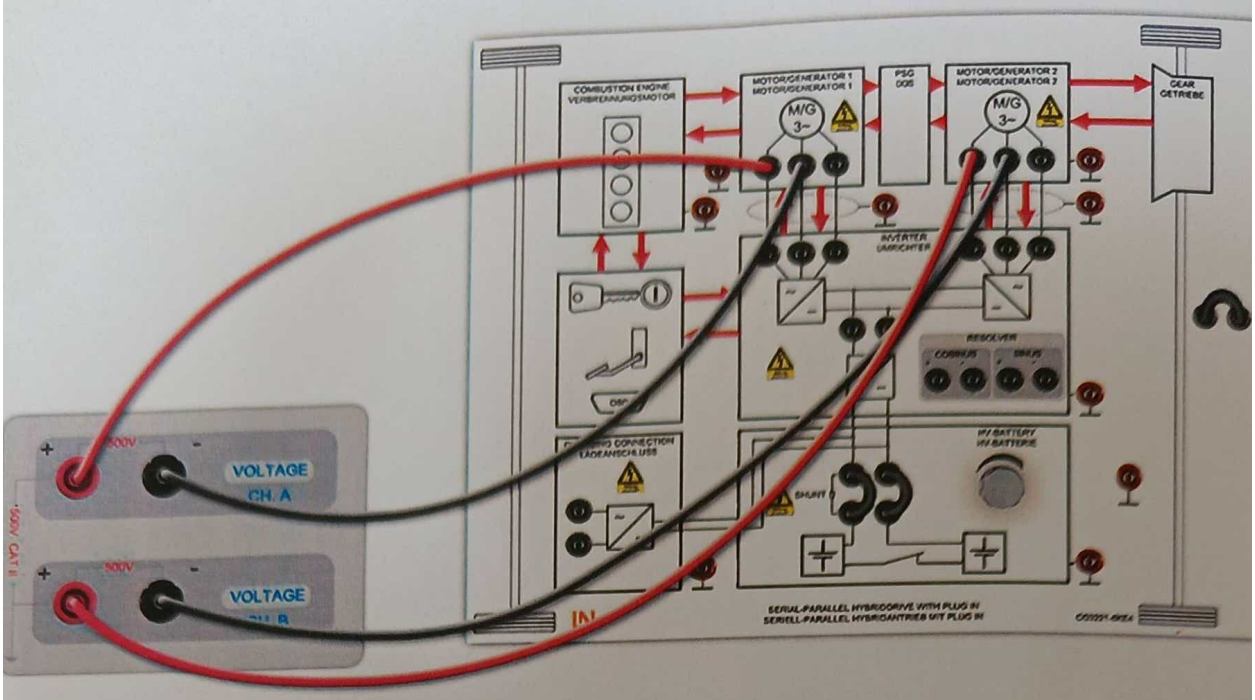
Cartrain setup, connecting wires, LN.
C03221-6K2 (Serial paralled Hybrid, drive train plugin)
Jumpers
Virtual Oscilloscope.

CONCEPT / THEORY OF EXPERIMENT:

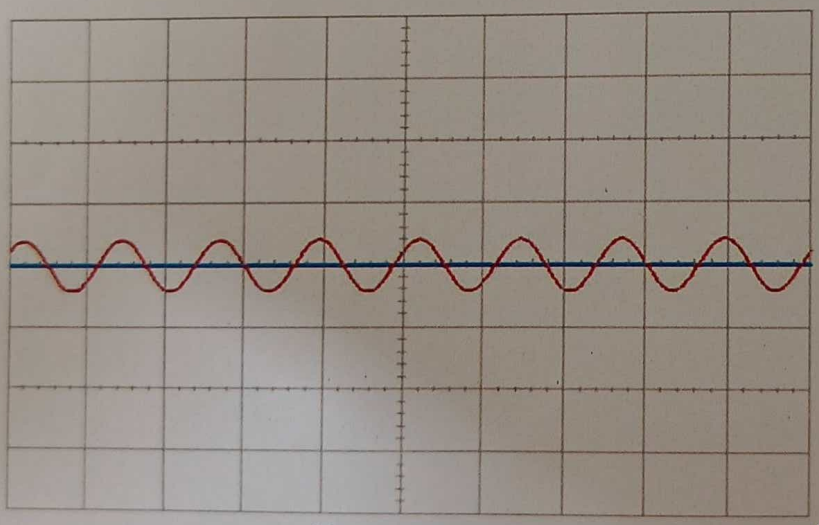
The serial parallel hybrid configuration is a system used in hybrid vehicle that continues features of both serial & parallel hybrid vehicles systems. It offers flexibility in how power is delivered to the wheels; improving efficiency and performance.

PROCEDURE :

1) Open Automative Course in LN software.
2) Open Series-parallel Hybrid chapter.
3) Do all the experiments listed one-by-one.
4) Observe the connections diagram and do the connections.
5) Obtain the waveform.
6) Also go through the content provided in LN.



Experiment Setup



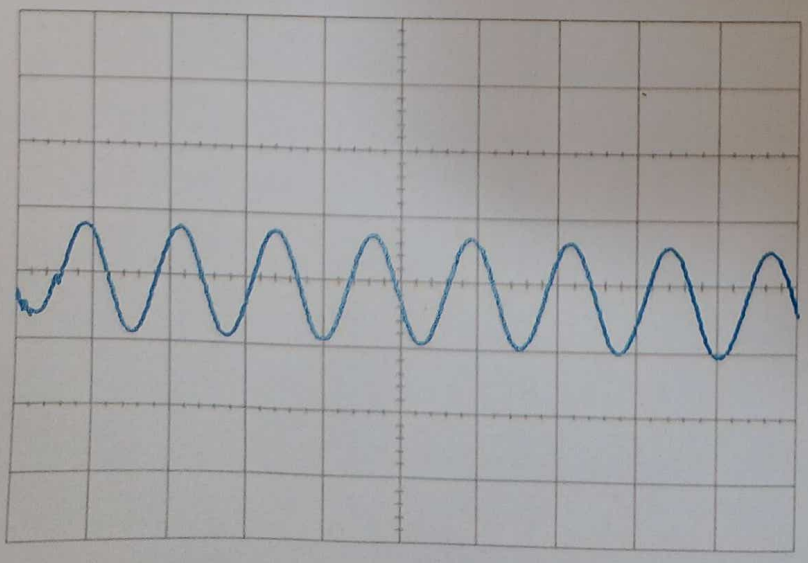
TIME/Div: 10 ms_

CHN 1/Div: 100 v_

CHN 2/Div: 100 v_

V_b : _____

Measurement: Trave on decline



TIME/Div: 10ms__

CHN 1/Div: 50 v__

CHN 2/Div: 0_____

V_b : 0_____

Measurement: Travel on flat terrain

OBSERVATIONS

Modes of Operation:-

a) Electric Only Mode:- Battery → Electric motor → wheels
- Used for low speed driving and short distances.

b) Series Mode:- Engine → Generator (Battery ONLY) → wheels)
- Engine charges the battery or power the motor; wheels are driven by the motor only.

c) Parallel Mode :- Engine → wheels Battery → Electric motor → wheels.
- Engine & motor together to drive the wheels directly.

d) Combined Mode:- Engine → wheels, Engine → Generator → wheels.
- Mix of series & parallel modes for high demand conditions.

e) Regenerative Braking Mode:- wheels → Electric motor → Battery
- Captures braking energy and stores it in the battery.

f) Idle Mode:- Battery → Auxillary systems.

Advantages:-

1) Can Operate in Electric only, engine only or Combined mode for better efficiency.
2) Optimizes fuel use by switching between the engine and mot depending on driving conditions.
3) Captures energy during braking to recharge the battery.

CALCULATIONS :

• Disadvantages :-

1) Requires more sophisticated control system and Integration of both power sources. Additional ~~integration~~ components increases vehicle weight impact fuel effeciency, Higher initial cost due to additional compunents. like dual motor & large battery.

• Applications :-

1) Passenger Vehicles :- Used in hybrid cars like Toyata, Prius, Honda, Accured Hybrid and Hyundai Ioniq Hybrid.

2) Public Transport :- Hybrid buses & taxis benifit from improved Fuel efficiency and lower emission.

RESULTS :

• Specifications of Series-Parallel Hybrid :-

1) Powertrain Configuration :- Combination of internal combustion engine (ICE) and electric motor.

2) Battery Type :- Typically uses lithium-ion or nickel-metal hybrid (Ni-MH) batteries.

3) Fuel Efficiency :- 20-40% better than Convential ICE Engine.

4) Electric Motor Power :- Ranges from 30 KW to 100 KW depending on vehicle model.

5) Emission :- Lower CO_2 emission compared to conventional ICE Vehicles.

CONCLUSION :

Hence, we performed the experiment to understand the parameters & operating modes for series-parallel Hybrid configuration of HEV's.

PRACTICAL NO: 4

Date : 27/01/25

TITLE : To study and analyze the performance of pure electric vehicles.

AIM / OBJECTIVE: The objective is to study and analyze performance of pure electric vehicle (EVs) in terms of efficiency, range, power consumption.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

Cartrain LN setup
Labsoft
PC
Multimeter
Connecting wires.

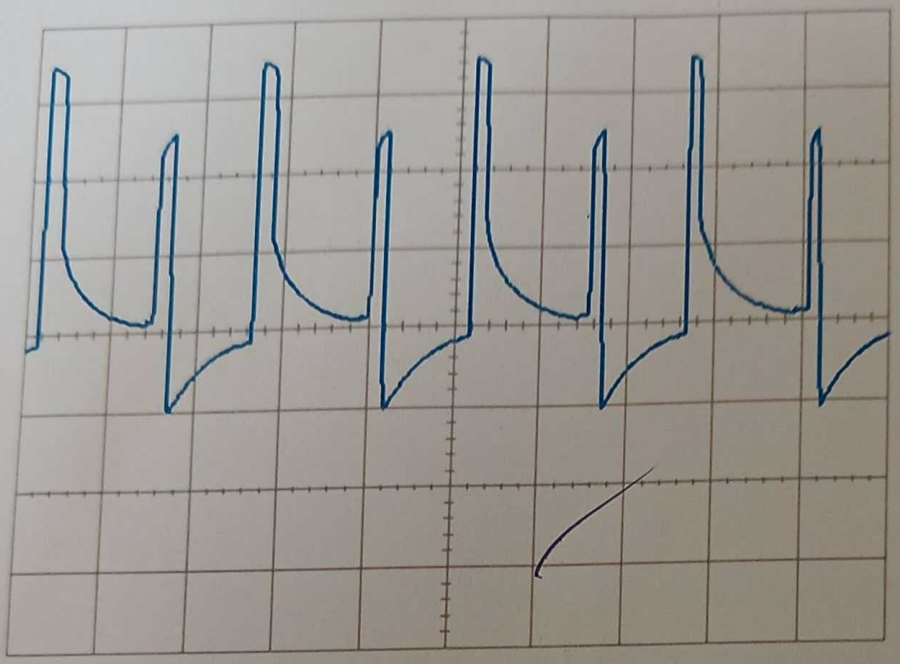
CONCEPT / THEORY OF EXPERIMENT:

Pure electric vehicle (EVs) use high energy density lithium ion or solid-state batteries to power electric motor, eliminating internal combustion engines. Their performance depends on battery capacity kwh motor, power electronics, regenerative backing and drivetrain losses.

PROCEDURE :

1) Turn ON the system using main switch, wait until boot is completed.
2) Now move the ignition key setting from 0-1.
3) The Energy Flow can be enlarged by touching cockpit display.
4) Use overlay on the system.
5) Now further based on given steps for task do the connection with battery and put shunts accordingly.
6) Set the RPM using potentiometer.
7) Use oscilloscope to view graph and observe energy flow.

Electric driving mode



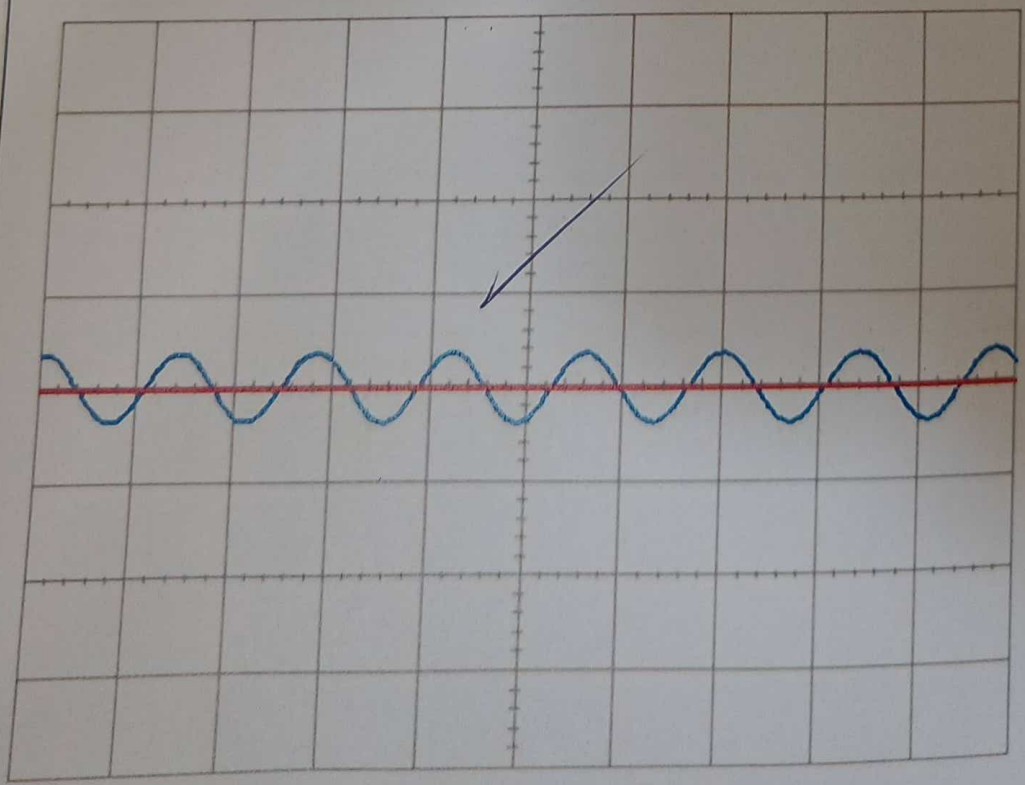
TIME/Div : 50ms

CHN 1/Div : 100v

CHN 2/Div : _____

V_b : _____

Energy recovery

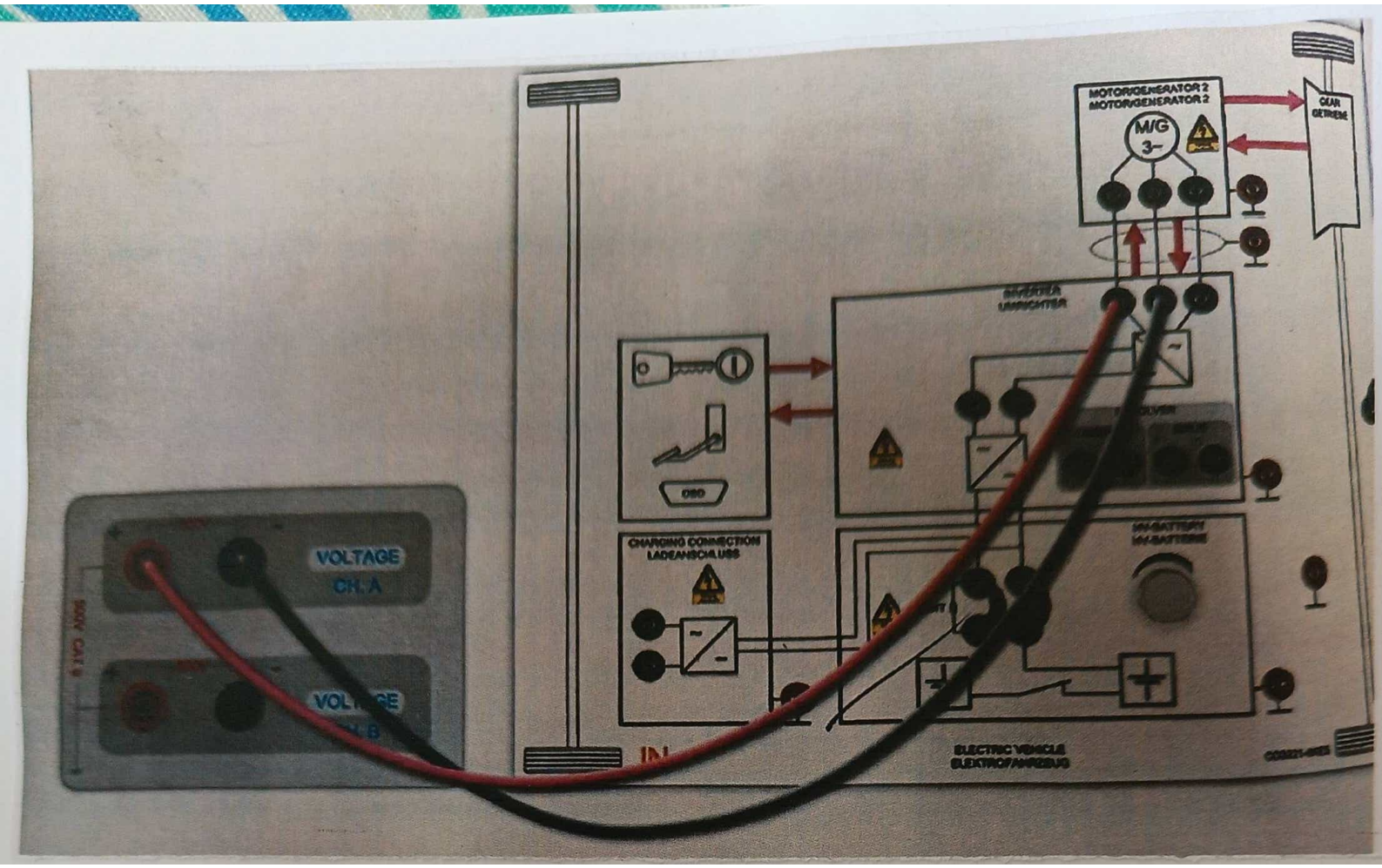


TIME/Div : 10ms

CHN 1/Div : 100v

CHN 2/Div : _____

V_b : _____


MOTOR/GENERATOR 2
MOTOR/GENERATOR 2
M/G
3~
GEAR
GETRIEBE
INVERTER
UMRICHTER
OBD
CHARGING CONNECTION
LADEANSCHLUSS
HV-BATTERY
HV-BATTERIE
VOLTAGE
CH. A
MAX CAT II
ELECTRIC VEHICLE
ELEKTROFAHRZEUG

OBSERVATIONS

I] Pure Electric Vehicle (EV) key Components :-

1) Battery Pack : Stores & supplies electrical energy.

2) Electric Motor : Converts electrical energy into mechanical motion.

3) Power Electronics : Includes the inverter and DC-DC converter for motor control and voltage regulation.

4) Regenerative Braking :- Recovers energy during braking to recharge the battery.

5) Thermal Management System :- Maintains optical temperature for battery and motor efficiency.

6) Onboard charger (OBC) :- Converts AC power to DC for battery charging.

7) Vehicle Control Unit (VCU) :- Manages power distribution and vehicle operation.

8) Drive Train :- Transfer motor power to wheels via single speed transmission.

II] Modes of Operation in Pure Electric Vehicle (EV's) :-

1) Idle Mode :- The vehicle is powered on but not moving, minimal energy consumption.

2) Electric motor Mode :- The motor draws power from the battery to increase speed.

3) Cruising Mode :- The vehicle maintains a constant speed with optimized energy consumption.

4) Regenerative Braking Mode :- The motor acts as a generator, converting kinetic energy into electrical energy to recharge the battery.

5) Decleration Mode :- The motor reduces power output while regenerative braking may assist in energy recovery.

CALCULATIONS :

III] Pros, Cons and Applications :-

Pros :-

1) Zero Emission :- No tailpipe pollution, reducing environmental impact.
2) High Efficiency :- Electric motors have over 80% efficiency compared to internal combustion engine.
3) Lower Operating Cost :- Reduced fuel and maintenance costs.
4) Regenerative Braking :- Enhances efficiency by recovering energy during breaking.

Cons :-

1) High initial cost :- Expensive battery technology increases upfront prices.
2) Limited Range :- Battery Capacity restricts long-distance travel.
3) Charging Time :- Longer refueling time compared to gasoline vehicles.
4) ~~vehicles~~

RESULTS :

Applications :-

1) Passenger Vehicles :- Used for personal transportation (cars, SUVs and sedans).
2) Public Transport :- Electric buses and taxis for urban mobility.
3) Commercial Fleets :- Logistics and delivery vehicles for sustainable transport.
4) Two and Three wheelers :- Electric scooters & rickshaws for short distance travel.

CONCLUSION :

Hence, we performed the experiment to understand the parameters and operating modes for pure electric vehicle.

PRACTICAL NO: 5

Date : 27/02/25

TITLE : To study and analyze the performance of fuel cells.

AIM / OBJECTIVE: 1) Different components of fuel cells.
2) Examining energy flow and modes of operation.
3) Identify the pro's, con's and applications and features.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

CarTrain LN setup
labsoft
Pc
Connecting wires.

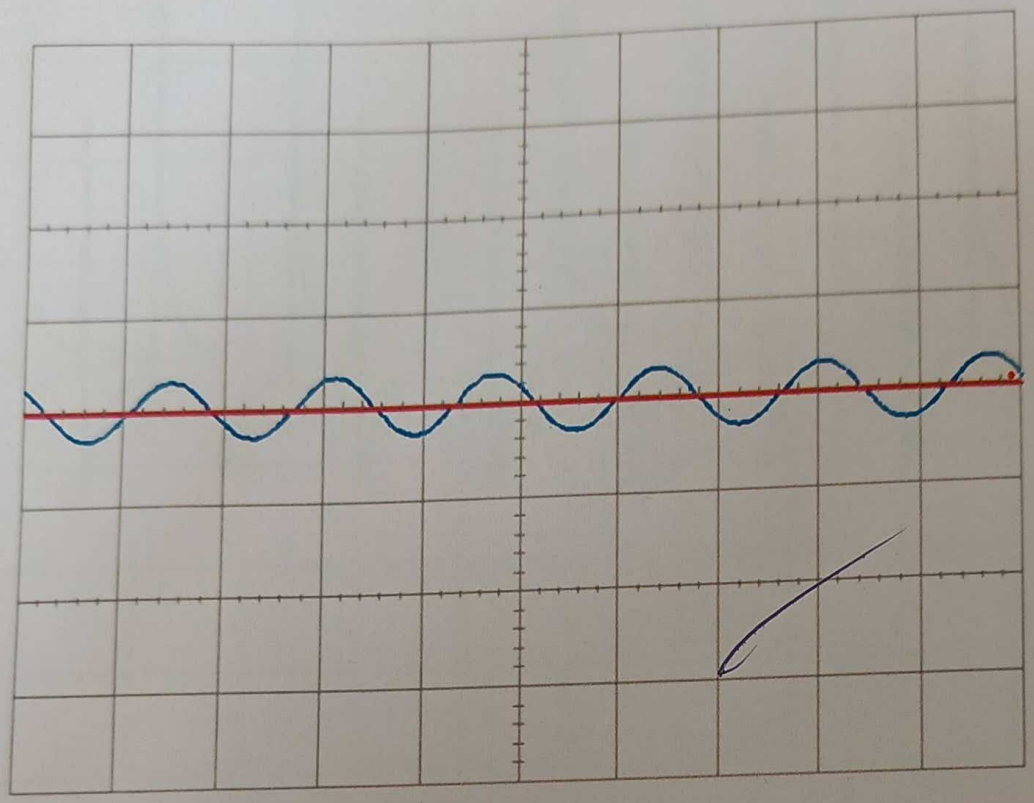
CONCEPT / THEORY OF EXPERIMENT:

FCEVs use a propulsion system similiar to that of Electric vehicles, where energy stored as hydrogen is converted to electricity by the fuel cell. Unlike conventional internal combustion engine vehicles, these vehicles produce no harmful tailpipe emissions.

PROCEDURE :

1) Turn on the system using main switch, wait until boot is completed.
2) Now move the ignition key setting from 0-1.
3) The energy flow can be enlarged by touching Cockpit display.
4) Use overlay on the system.
5) Now further based on given steps for task to do connection with battery or multimeter and put shunts accordingly.
6) Set RPM using potentiometer.
7) Use oscilloscope to view graph and observe energy flow.

Measurement with combined energy recovery



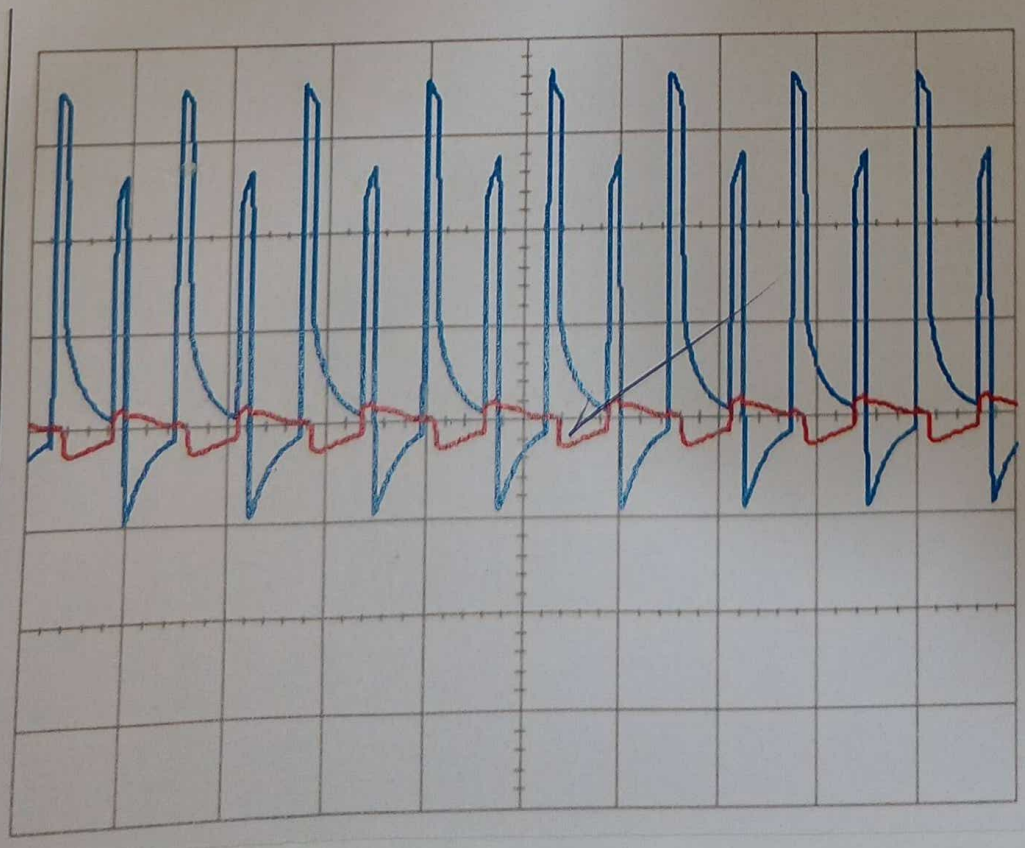
TIME / Div : 10ms

CHN 1 / Div : 100v

CHN 2 / Div : _____

V_b : _____

Measurement with the fuel cell active



TIME / Div : 100 microseconds

CHN 1 / Div : 100 v

CHN 2 / Div : _____

V_b : _____

Fuel Cell Key Components

1) Anode :- The negative electrode where hydrogen splits into protons and electrons.

2) Cathode :- The positive electrode where oxygen reacts with protons and electrons to form water.

3) Electrolyte :- A medium that allows protons to pass from anode to cathode while blocking electrons.

4) Catalyst :- Speeds up the reactions at the anode & cathode (often platinum).

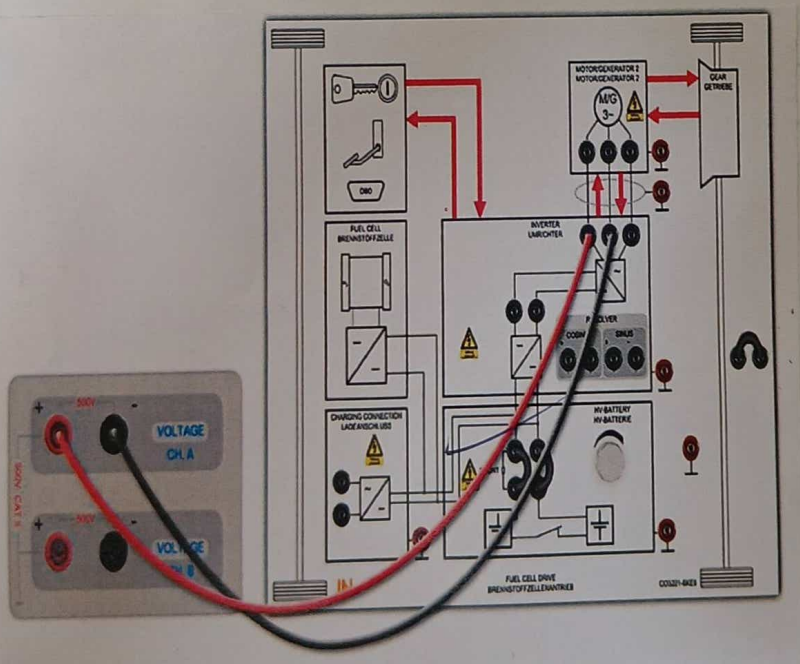
5] Flow Plates :- Distributes gases & collect electricity.

6] Gas Diffusion layer :- Distributes gas evenly and manages water.

7] Current Collectors :- Conduct electricity to the external circuit.

Energy Flow and modes of Operation

- Configuration diagram for fuel cell :-



OBSERVATIONS

• Energy Flow :- Hydrogen is split at anode, creating protons and electrons. The protons pass through the electrolyte, while electrons generate electricity in the external circuit. Oxygen combines with protons and electrons at the cathode to form water.

• Modes :-

Fuel Cell mode :- The fuel cell alone powers the vehicle.

Hybrid mode :- Combines fuel cell with batteries or supercapacitors for extra power.

Regenerative :- Energy is stored during braking mode.

* Pro's and Con's of Fuel Cells *

• Pro's :-

1) High Efficiency :- More efficient than internal combustion engine.
2) Zero Emissions :- Only water vapour is produced.
3) Quick Refueling :- Takes minutes to refill hydrogen, unlike long charging time for BEV's.
4) Long Range :- Higher range than battery electric vehicle.
5] Reduced emissions :- With zero tailpipe emissions, FCEV's help to reduce air pollution.

• Con's :-

1) Infrastructure :- Limited hydrogen stations and expensive setup.
2) Cost :- High production cost due to complex technology and materials.
3) Hydrogen production :- Often comes from natural gas, which has emissions.
4) Storage and Transport :- Hydrogen needs high pressure or liquid storage, which is costly & tricky.

CALCULATIONS :

* Key Features :-

1) Hydrogen System :- Fuel cell combined with battery for extra power.

2) Regenerative Braking :- Captures braking energy.

3) Advanced Control System :- Fuel cell vehicles features sophisticated energy management system to optimize fuel consumption & power output

4) Quiet Operation : Minimal noise compared to combustion engine.

5) Sustainability :- Can use renewable hydrogen production method.

RESULTS :

* Applications :-

1) Passenger Vehicles :- Fuel cell cars like Toyata mirai and Hyundai Nexo.

* Environmental and Safety Specifications :-

1) Zero Carbon Emissions :- Produces only water vapour (H_2O) and by product.

2) Reduced air pollution :- No NOx, SOx, particular matter emissions.

CONCLUSION :

Hence, we understand various parameters and operating modes of fuel cell based electric vehicles.

PRACTICAL NO: 6

Date : 10/02/25

TITLE : To study and understand and analyze the performance of CRDI actuators.

AIM / OBJECTIVE: 1) To study about actuators and CRDI performance.
2) To study construction, working, features of various actuators and applications.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

1) Laptop / PC.
2) LN labsoft.
3) Connecting wires.
4) CRDI System (car-train).

CONCEPT / THEORY OF EXPERIMENT:

The CRDI system is a technology where highly pressurised fuel is supplied to injection through a common rail. As the name indicates it is a direct injection system where the injection sprays fuel.

PROCEDURE :

1) Open the LN labsoft and then the machine cartrain.
2) Open the theory section and study the theoretical part of the actuator used in CRDI System.
3) Do the necessary wire connections.
4) Note down the voltage & graph obtained from the experiment.
5) Obtain the voltmeter readings.

1) Rail Pressure Regulator :-

Construction :- It involves a solenoid valve connected to a pressure sensor and spring loaded piston.
- It is connected to the common rail in CRDI system.
- It includes an electronic control system to adjust pressure.

Working :- 1) The pressure sensor monitors the fuel pressure in common rail.
2) Based on sensor, the ECU sends signal to the solenoid valve.
3] The solenoid valve adjust the pressure by controlling the fuel returning to the fuel tank.
4) The spring loaded in piston helps regulate the flow of pressure within derived range.

Features :- · Maintains optimal fuel pressure.
· Ensures efficient combustion & fuel economy.
· Helps reduce emission & engine knocking.

Readings :- Voltage 13.5 V.

2) Low Pressure Supply Pump :- It consists of electric or mechanical pump. It includes a fuel filter & a pressure regulator. It is mounted near the fuel tank (Construction).

Working :- · It draws fuel from the tank and sends it to the high pressure pump.
· Maintains a steady supply of fuel for injection.
· It operates at low pressure compared to high pressure pump.

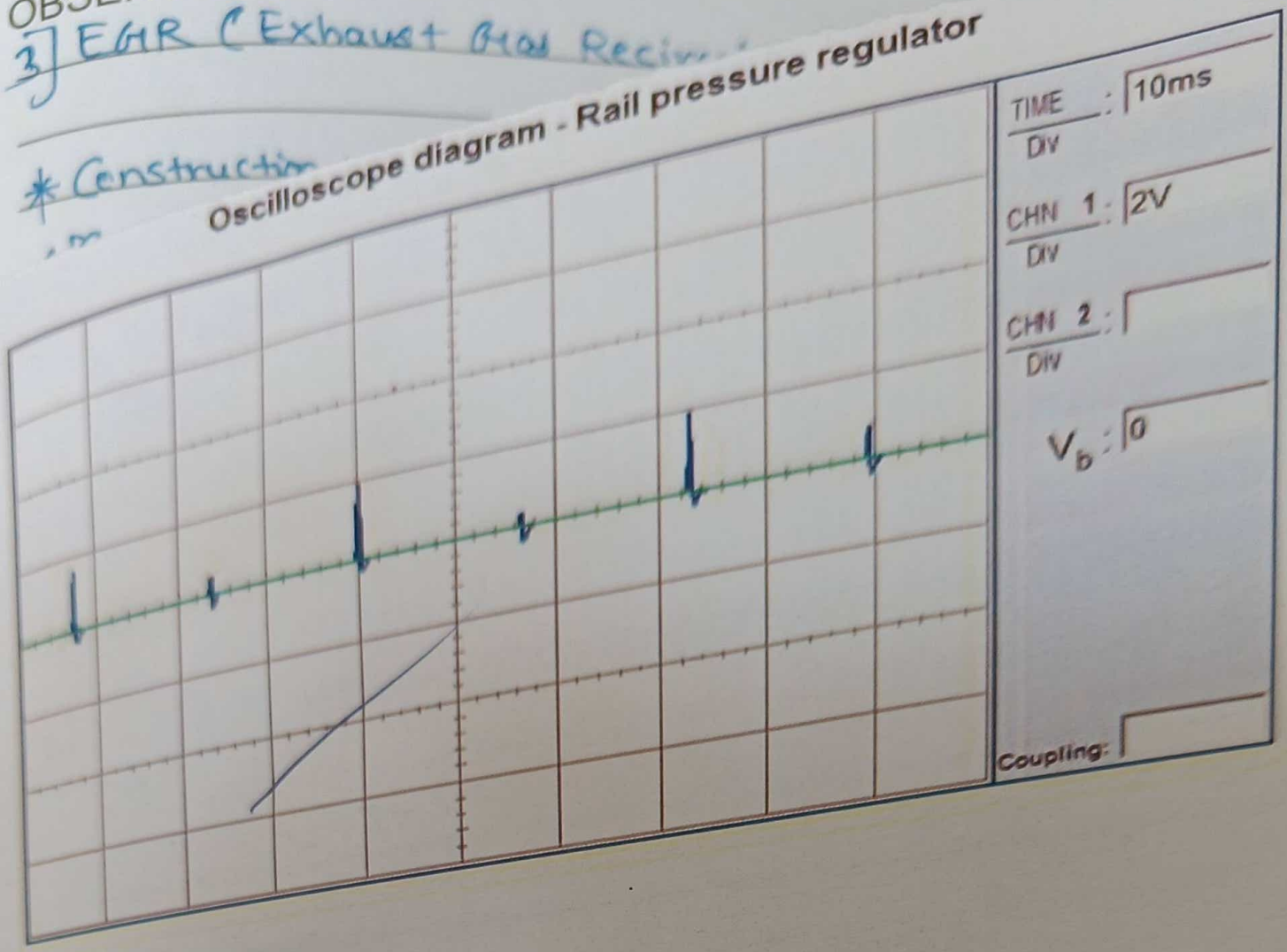
Features :- 1) Ensures a continuos fuel supply.
2) Prevents Vapour lock issues.
3) Enhances fuel system efficiency (voltage - 13 V).

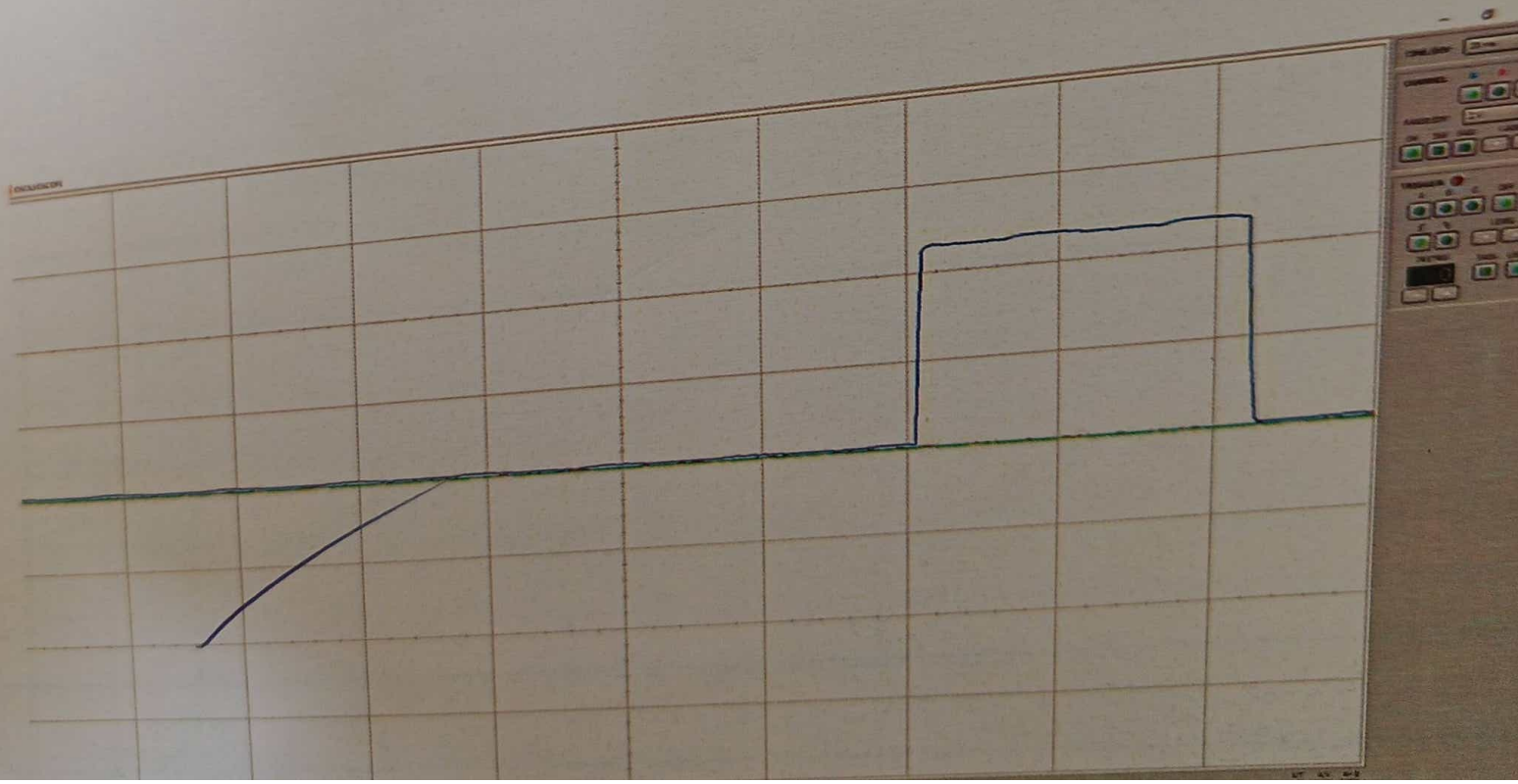
OBSERVATIONS

3] EGR (Exhaust Gas Recir...

* Construction

Oscilloscope diagram - Rail pressure regulator



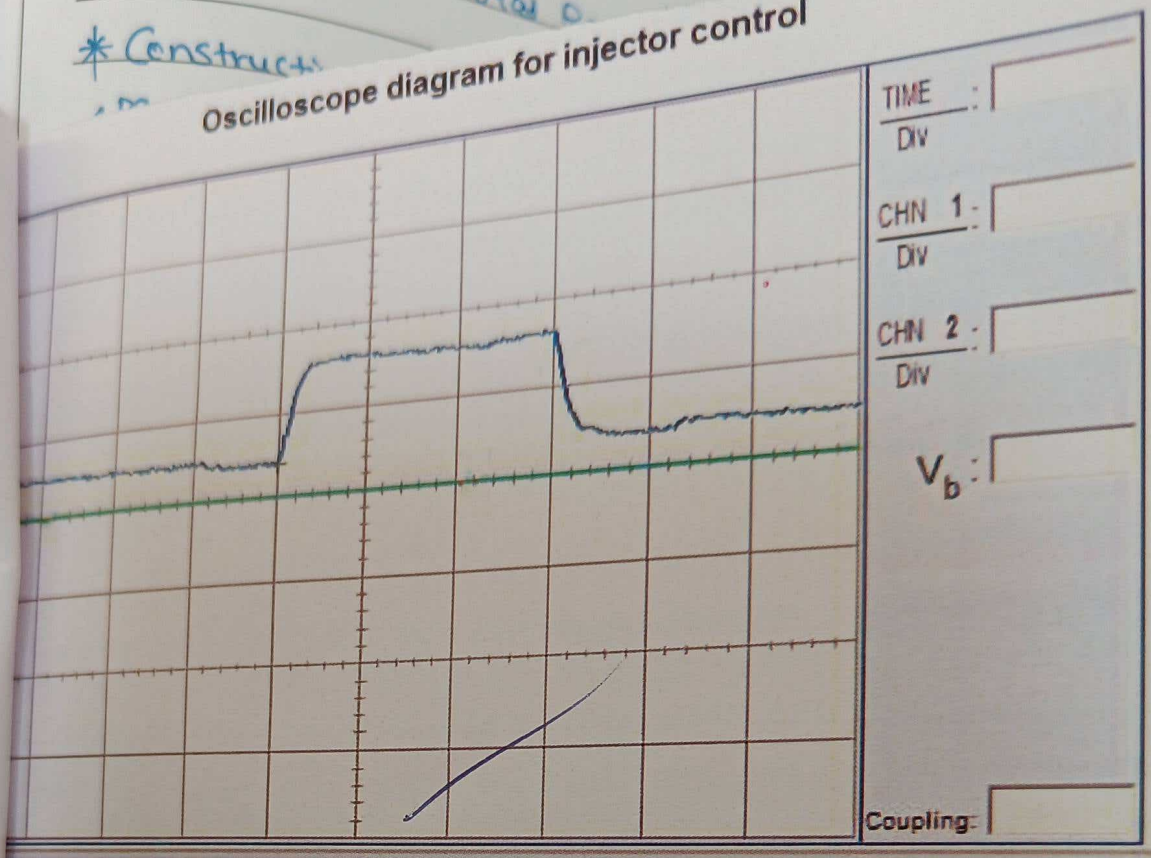


OBSERVATIONS

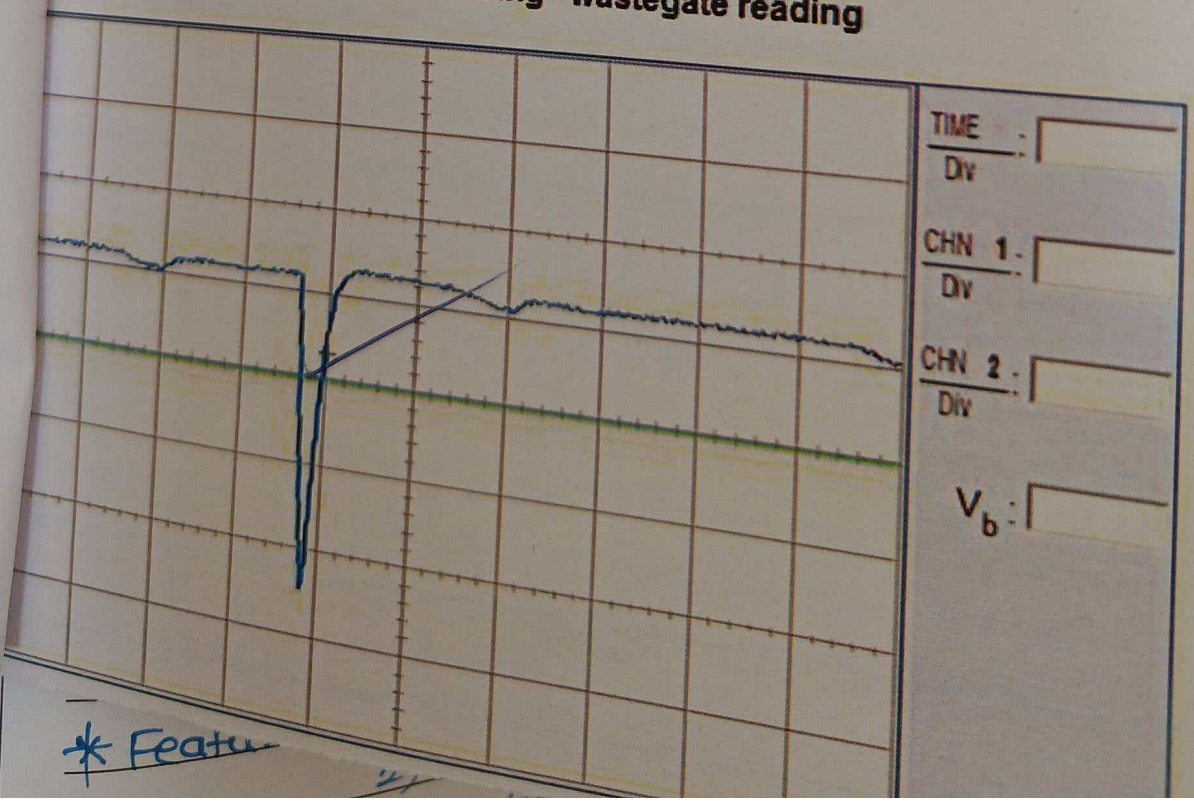
3] EGR (Exhaust Gas R

* Construct

Oscilloscope diagram for injector control



Oscilloscope reading - wastegate reading



* Featu

OBSERVATIONS

3] EGR (Exhaust Gas Recirculation) Control solenoid :-

* Construction :-
- Made up of an electronically controlled solenoid valves.
- It is connected to the intake and exhaust manifield via EGR passage.
- It is controlled by the ECU.

* Working :- It regulated the amount of exhaust gas recirculated into the intake manifield.
- The solenoid opens/close based on engine temperature and load conditions.
- Reduces Nox emissions by lowering combustion, temperature.

* Features :- Reduces nitrogen oxide (Nox) emission.
- Improves fuel efficiency in some cases.
- Helps in meeting emission norms.

Readings : Voltage measurement : 13.4 volts.

4] Wastegate Control (Solenoid) :-

* Construction :- It includes an electric solenoid value.
- Connected to the turbo charger wastegate actuator.
- Controlled electronically by ECU.

* Working :- Regulates turbo boost pressure by controlling the wastegate actuator.
- The solenoid opens to allow exhaust goes to bypass the turbine, reducing boost.
- The ECU adjusts solenoid operation based on engine load and speed.

* Features :- 1) Prevents excessive turbo boost pressure.
2) Enhances engine efficiency and longevity.
3) Helps in avoiding turbo charger damage.
4) Engine protection.

Readings :- Wastegate solenoid : 13.5 V.

CALCULATIONS :

5] Glow Plug :-

* Construction :- It is heating element enclosed in a metal shaft.
- It is installed in the cylinder head near the fuel injectors.
- Electrically powered for quick heating.

* Working :-
1) Heats up when electric current is supplied.
2) Assists in ignition of diesel fuel in cold conditions.
3) Switches off once the engine reaches operating temp.

* Features :-
1) It enables easy cold starts in diesel engine.
2) It reduces white smoke emission during startup.
3) It improves combustion efficiency.

Readings :- Glow Plug :- 13.5 V.

RESULTS :

We obtained the waveforms of the various actuators & the voltage outputs of the actuators.

CONCLUSION :

Hence we studied & analyzed performance of different types of actuators used in CRDI systems.

PRACTICAL NO: 7

Date : 10/02/25

TITLE : To study & analyze the working of CRDI system and sensor related to it.

AIM / OBJECTIVE:
1) To study working principle of various sensor.
2) To list various features and specifications.
3) To list applications of sensors.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

1) CRDI Apparatus.
2) PC
3) LV labsoft
4) Connecting Wires.

CONCEPT / THEORY OF EXPERIMENT:

The CRDI is an intelligent technology where the highly pressuried fuel is supplied as injection through a common rail. As the name indicates it is directly injection system where injectors spray fuel directly to the system.

PROCEDURE :

1) Turn ON LV labsoft (cartrain) and navigate to CRDI course.
2) Read the course & understood the working of CRDI system.
3) Perform the experiment on various sensors of the CRDI system.
4) Measure the important parameters of the sensors such as output voltage, signal type, etc.

1] Acceleration Pedal Sensor :-

• Working :- The APS sends the position data to the ECU which uses the signal to adjust fuel injection of air intake of engine power.

Types of Accelerator Pedal Sensor :-

1) Potentiometer based Sensor :- Variable resistor to change voltage.

2) Hall Effect Sensor :- Uses magnetic field changes to determine pedal positions.

Readings : Voltage (DC) = 5V

Voltage at minimum Idle condition = 0.4 V.

at maximum = 3.25 V.

2] Camshaft Sensor :-

1) Function :- Used to monitor the camshaft position and the speed of engine.

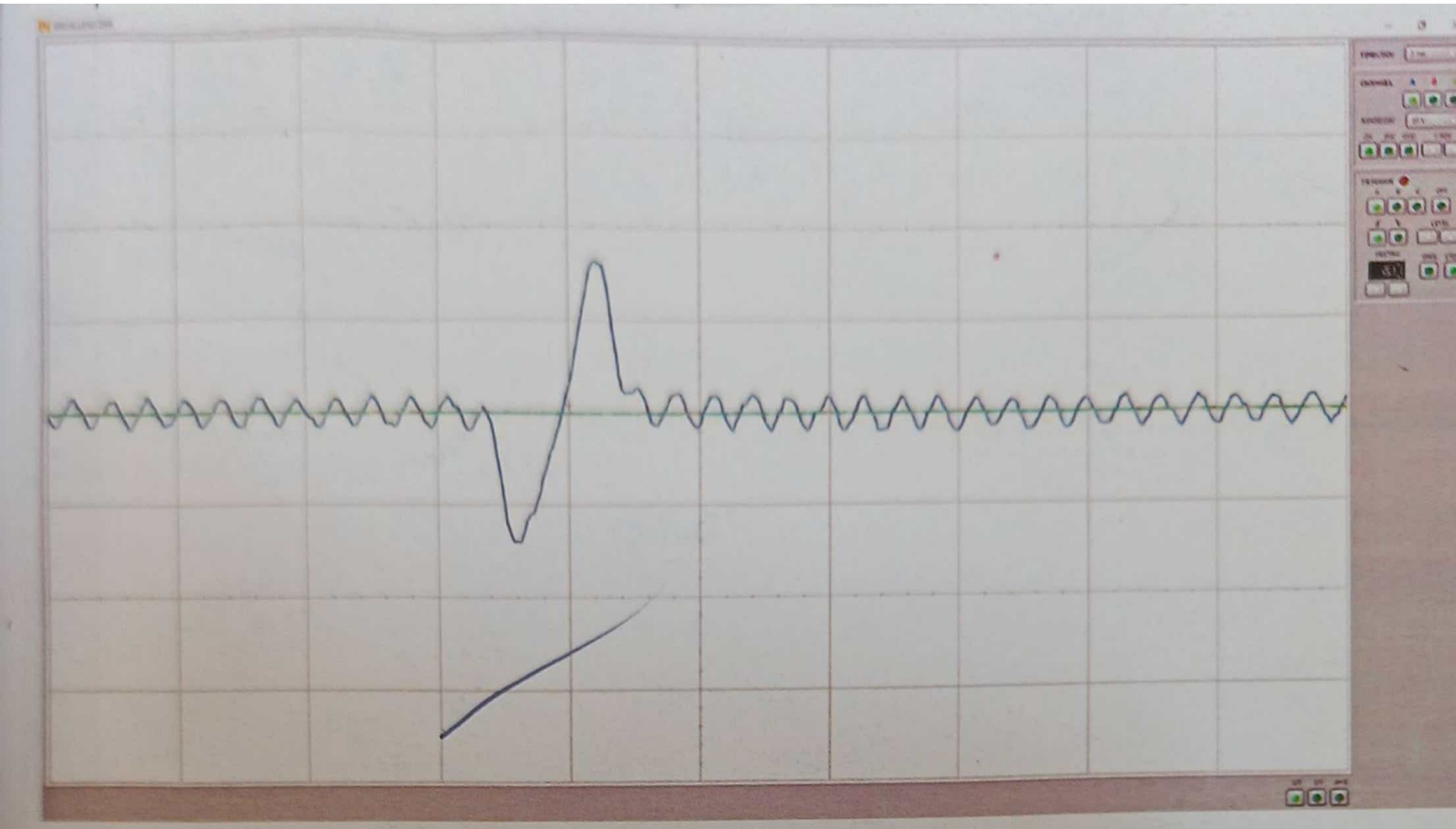
2) Working :. It detects camshaft rotation, generating electrical signal. The ECU uses these signals to determine camshaft position relative to crankshaft variable valve timing.

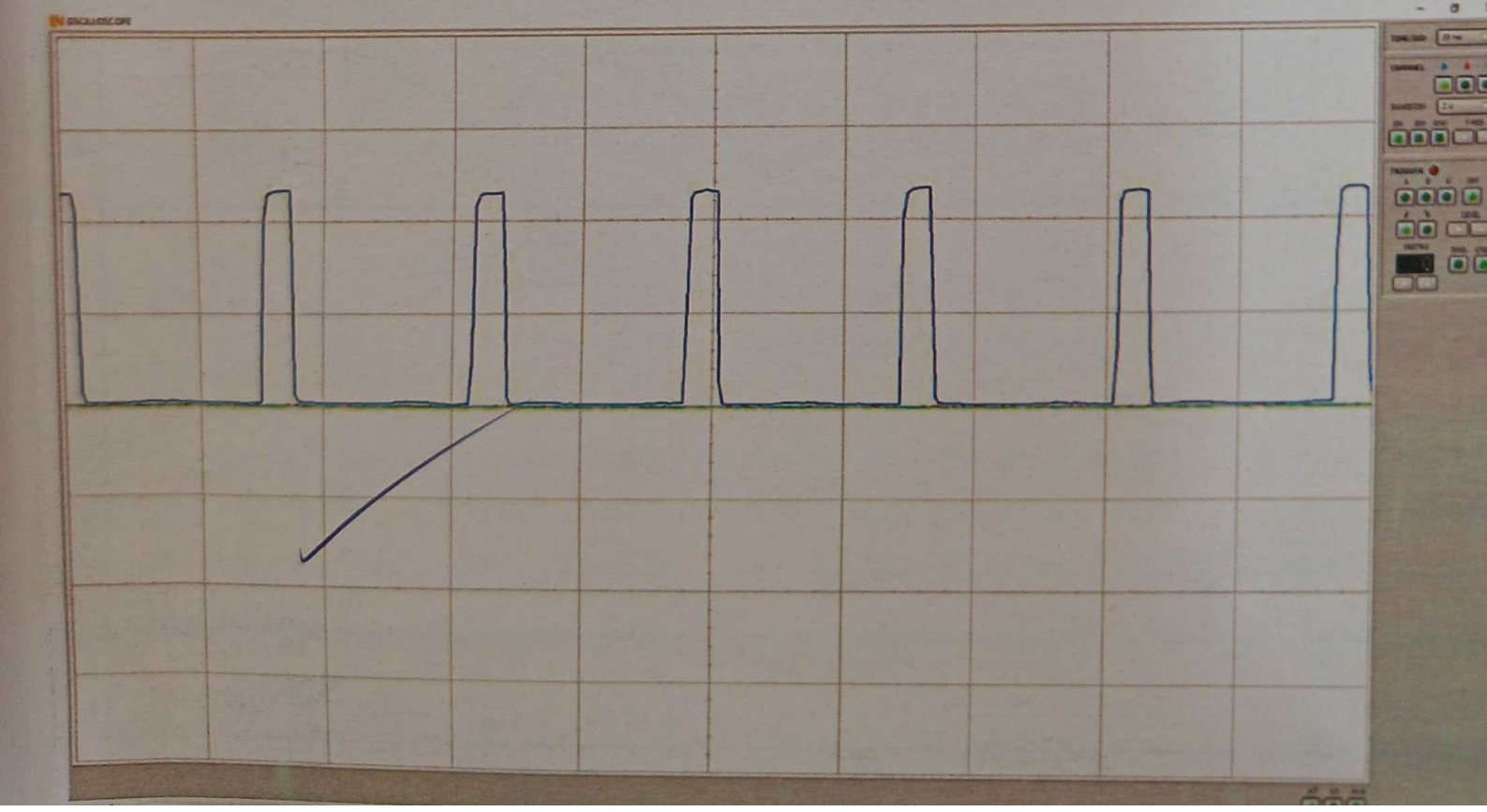
Readings :- DC voltage at idle = 5V.

3] Coolant Temperature Sensor :-

1) Function :- Used to measure the temperature of engine coolant, ensuring the engine operations with its optimal temperature range.

2) Working :- The sensor typically uses a thermistor to measure coolant temperature. As temperature changes the resistance of thermistor changes ; allowing the sensor to send varying voltage.





SERVATIONS

Crankshaft Sensor :-

Function :- Determines the position and speed of the crankshaft, esential for proper fuel injection timing and ignition timing.

Working :- There are various types of crankshaft sensor, including hall effect sensor and optical sensor, They generate signal as teeth of crankshaft passes by.

Readings :- AC voltage at idle
at 50 % =
at 100 % =

5] Air Intake Temperature Sensor :-

Functions :- Measures the temperature of the incoming air, allowing ECU to adjust fuel injection quatity and timing for optimal combustion.

Working :- Similar to the coolant temperature sensor the intake sensor uses thermistor to measure temperature change in intake air.

Readings :- Voltage DC at low speed:
Voltage DC at high Speed:

6] Mass Airflow sensor [MAF] :-

Functions :- Measures the mass of air entering the engine crucial for calculating the appropriate amount of fuel needed for consumption.

Working :- The MAF sensor basically uses heated wire of rim to measure airflow.

CALCULATIONS :

7] Rail Pressure Sensor :- Monitors the fuel pressure in the common rail ensuring consistent & accurate fuel delivery to the injection.

• Working :- The rail pressure sensor measures pressure inside Common rail and sends ~~dat~~ pressure data to ECU allowing it to adjust injector pulse width & timining.

8] Map Sensor [MAP: Manifield Absolute Pressure]:

Functions :- 1) The Map sensor detects air pressure (vaccum) inside intake manifold.
2) Sensor sends a voltage signal to ECU.
3) It converts this pressure into an electrical signal.
4) Voltage varies based on pressure.

Types of Map Sensor :- Analog MAP Sensor.
Digital MAP Sensor.

RESULTS :

Applications of CRDI System :-
1) Automotive Industry :- Passenger Vehicle, Commercial vehicle, Offroad vehicle.
2) Marine Industry :- Diesel Engines are used in boats & ships for better fuel economy.
3) Railway Industry :- Diesel locomotives uses CRDI.
4) Power Generation :- Diesel generaturs uses CRDI.

CONCLUSION :

Hence, we analyzed the working & performance of various sensors in CRDI System.

PRACTICAL NO: 8

Date : 17/02/2025

TITLE : To study and analyze the performance of power converter, inverters and regenerative braking in EVs.

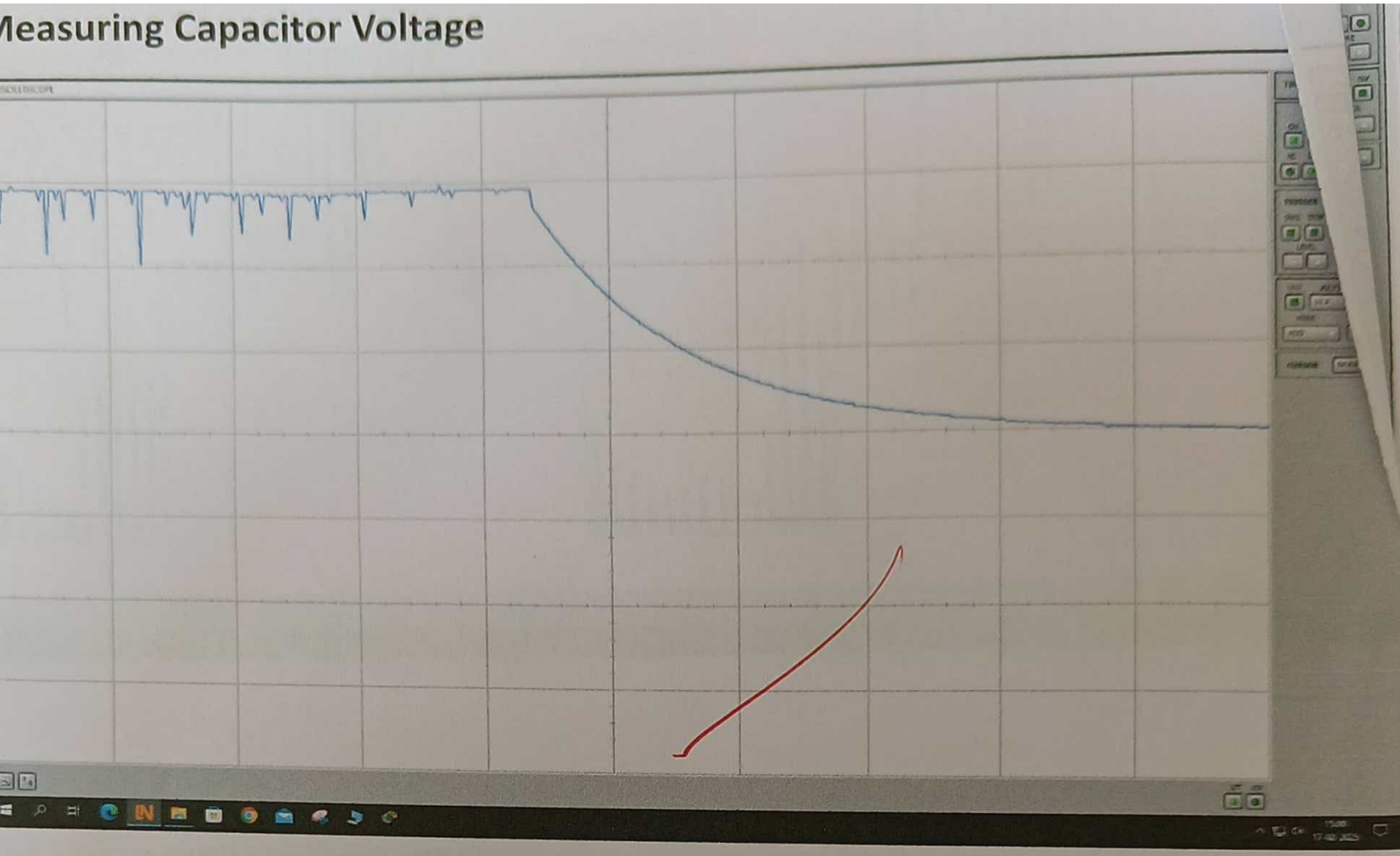
AIM / OBJECTIVE:
1) Understand the performance of power converter.
2) Understand the working of inverters and converters.
3) Understand the working and performance of regenerative braking.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:
Unitrain Cards - S04203-4A, S04203-4F, S04203-7T
LN labsoft software
Unitrain Experimenter
→ Concept → Power converters – These transform electrical energy from one form to other, such as connecting AC to DC.

CONCEPT / THEORY OF EXPERIMENT:
Inverters :- Inverters converts direct current (DC) to alternating current (AC) by using electronic switches like transistors. They typically use PWM to shape the output.
Regenerative Braking :- This concept is used to recharge a battery or capacitor in an HEV/EV. It converts kinetic energy from the motor as a generator into electrical energy.

PROCEDURE :
1) Open LN labsoft software and navigate to and unitrain and hybrid in Automobile course.
2) Follow the instructions as given in the course and perform accordingly.
3) Observe the waveform on oscilloscope and voltages on the virtual voltmeter as instructed.
4) Verify the output.

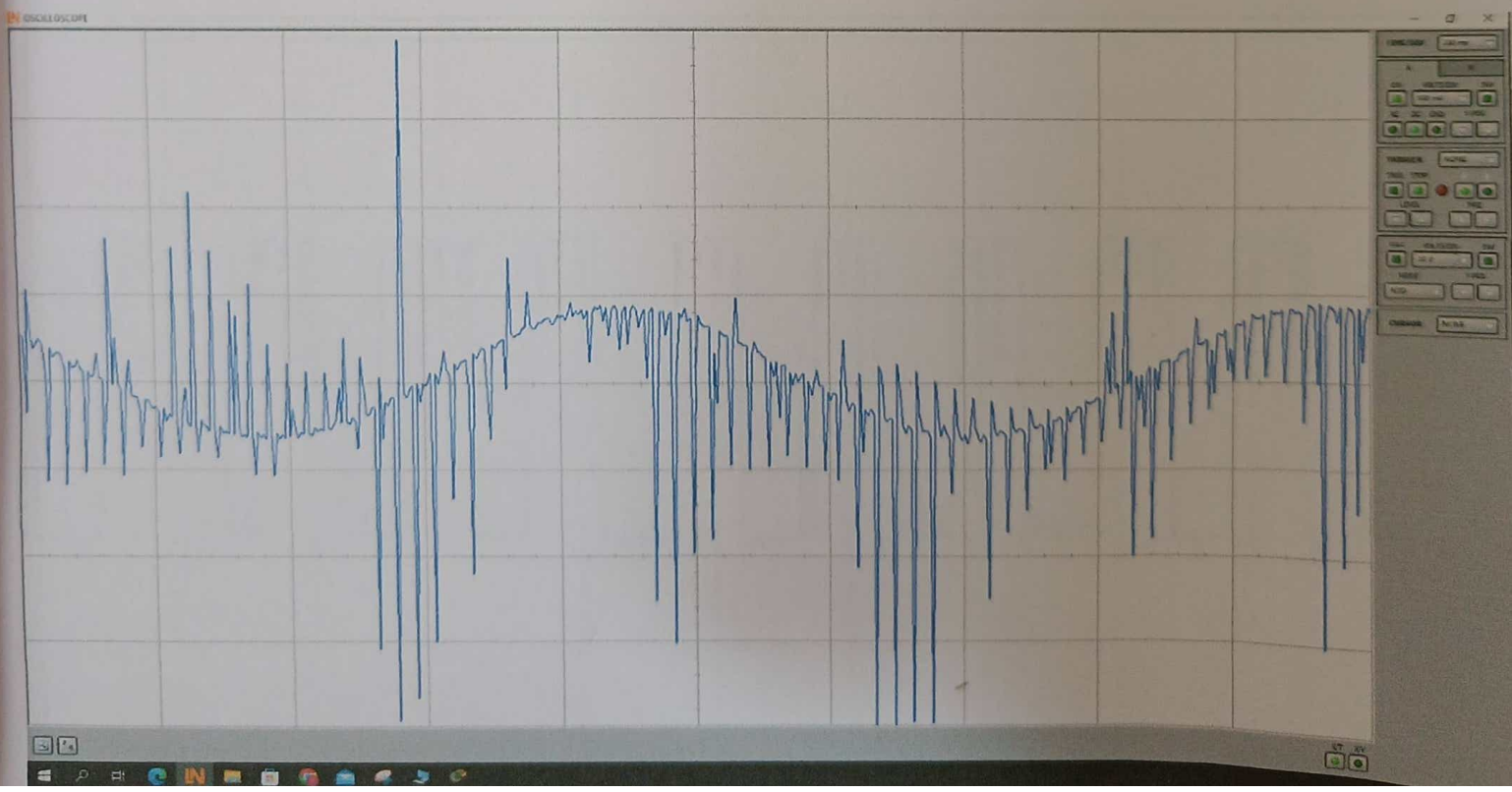
Measuring Capacitor Voltage



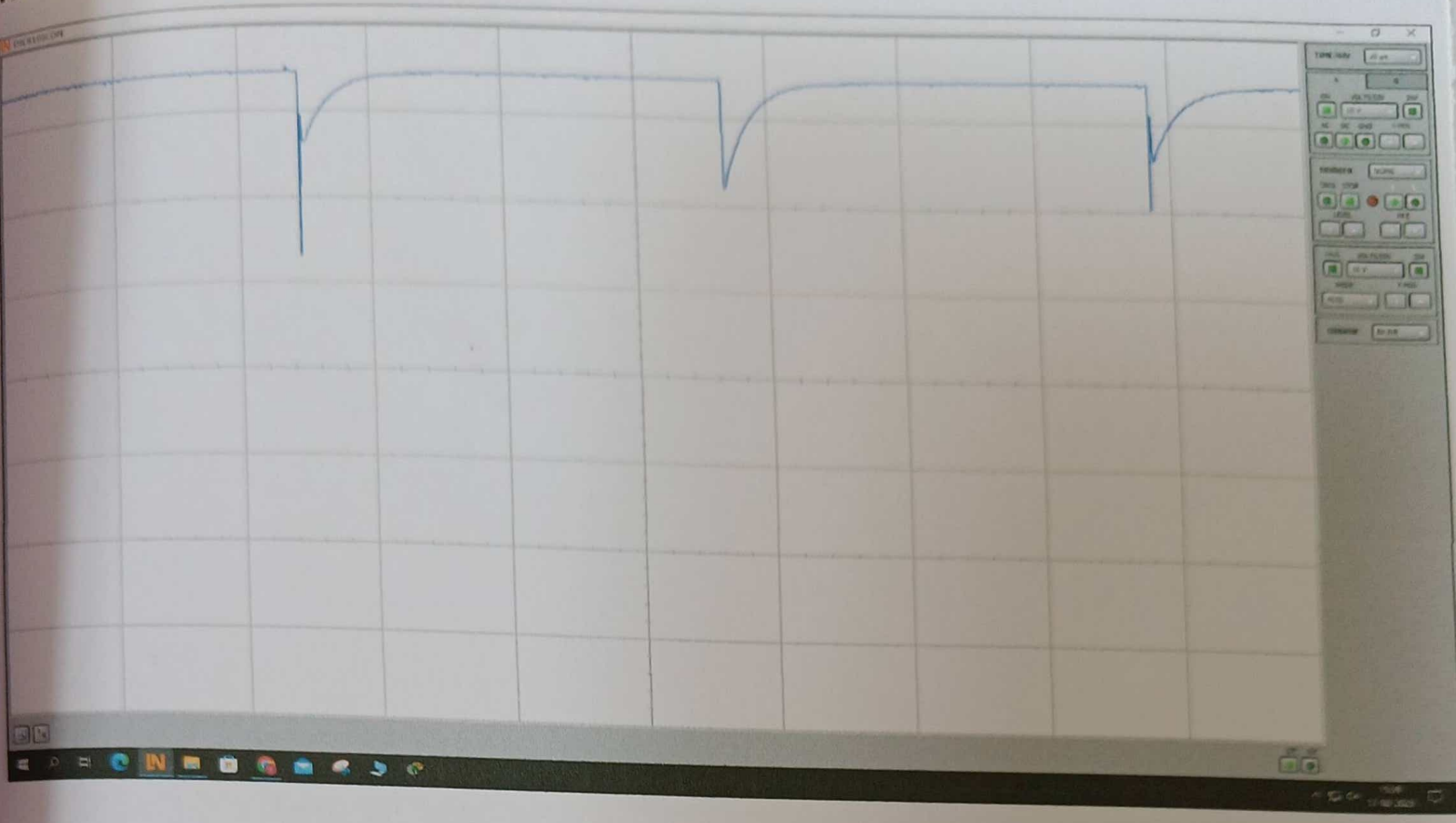
Inverter Measurements (U1U2)

Inverter Measurements

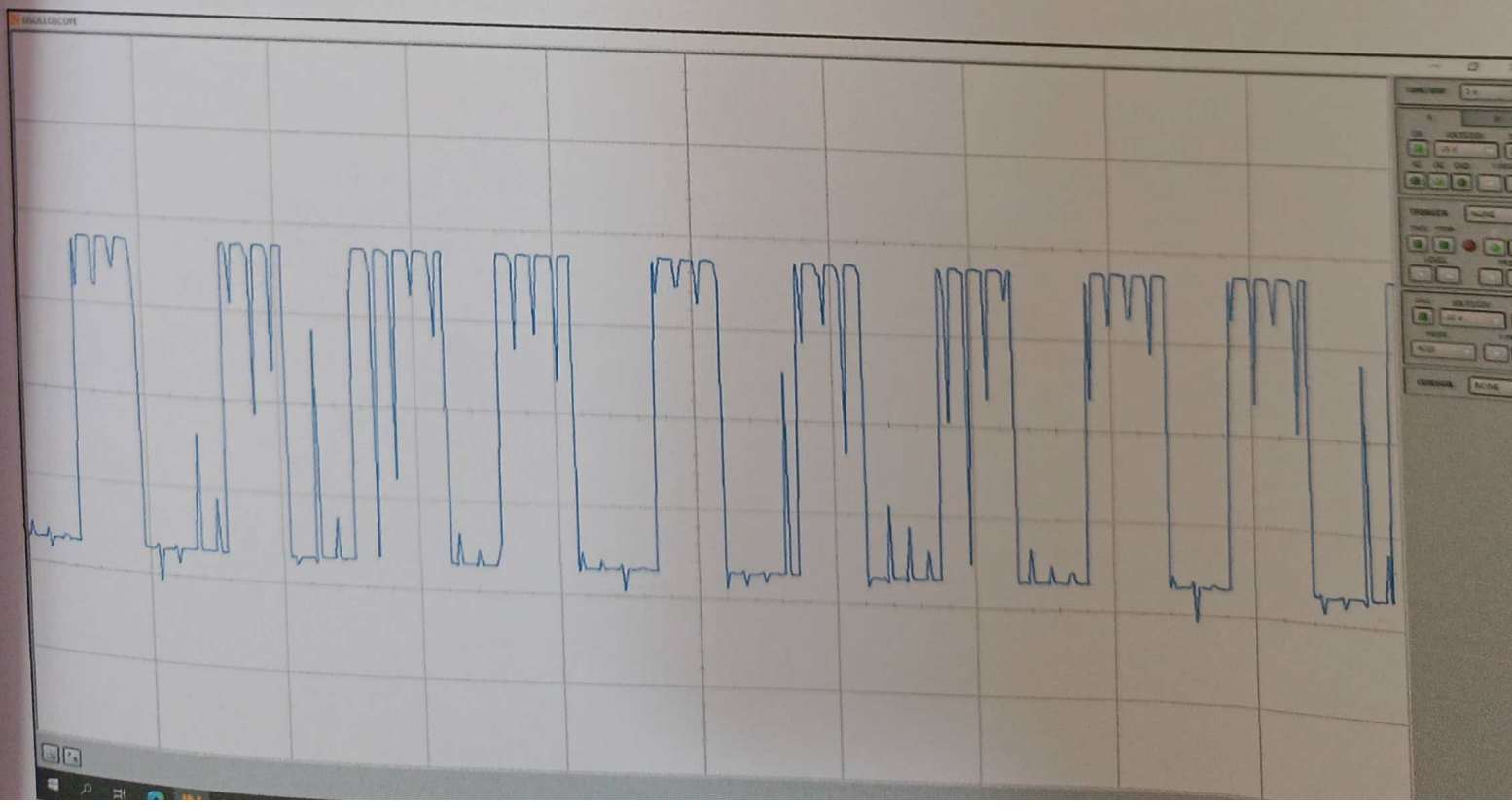
Inverter Measurements (R1)



Measurement of Input Voltage



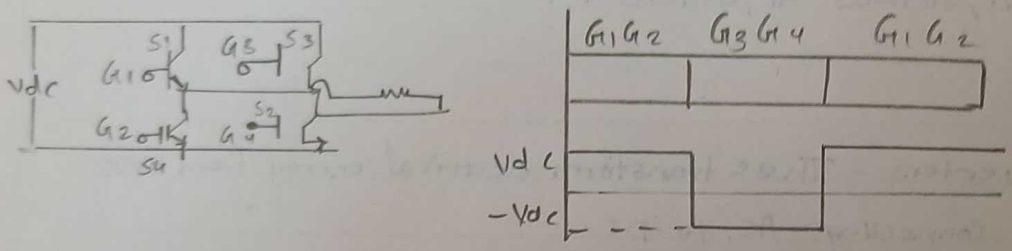
Measurement of Output Voltage



This type of rectifier has a three phase input voltage supply. They also do not have a zero point hence the output power is much higher than for single phase input.

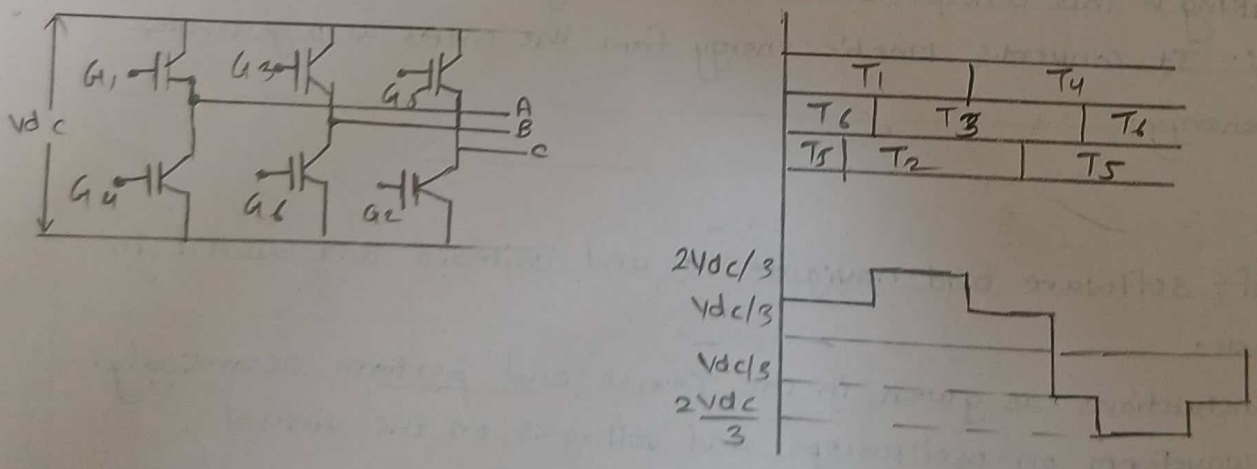
- Inverter:- An inverter is an electrical circuit that converts DC to AC. As the vehicles require AC for their operation. There is need for an inverter circuit. The inverter uses PWM to turn on and off the PED devices.

1) Single phase Output:-



The IGBT S_1 & S_2 are triggered on and they remain on from 0 to π, The IGBTs S_3 and S_4 are triggered on & they remain on from π to 2π this gives an AC voltage at output.

2) Three phase Output :-



The IGBTs are triggered ON and OFF in a specific pattern to achieved a three phase output voltage.

OBSERVATIONS

1) Rectifier:-

a) Single Phase Supply:-

1) The input voltage at V_1 to COM ($V_{VI,COM}$) = 13.8 V.

2) The link voltage V_D = 16.3 V

3) The motor voltage V_{UW} = 9.5 V

b) Three Phase Supply:-

1) The input voltage at V_1 to V_2 ($V_{V_1V_2}$) = 23.7 V

2) The link voltage at V_D = 29.3 V

3) The motor voltage V_{UW} = 20 V.

2) Inverter :-

a) Measurement of input voltage :-

1) The input voltage of inverter = 34 V

2) The input voltage is a DC voltage

b) Measurement of Output voltage :-

1) The value of positive voltage is 18 V.

2) The value of negative voltage is -18 V.

3) A transistor remains conductive for 600ms.

c) Inverter Measurement (2)

1) The input voltage is 30 V.

2) The output voltage by the inverter is AC voltage.

CALCULATIONS :

3) Regenerative Braking :-

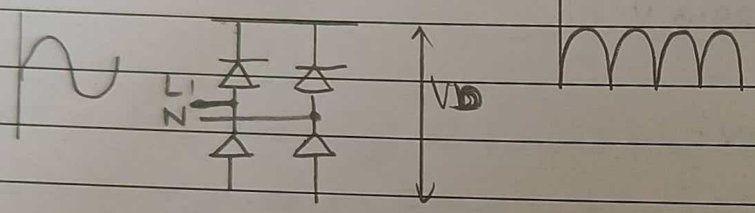
a) Energy Recovery

1) The induced voltage is 0.5 V

Theory :

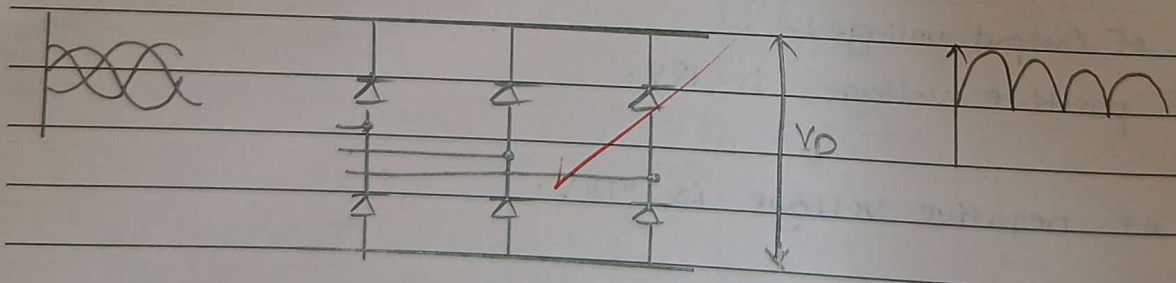
1) Rectifier :- A rectifier is an electrical circuit that converts AC to DC. As same of the components and systems in a vehicle require DC for their operation. There are 2 types of rectifiers based on the input supply voltage phase.

1) Single-phase feed :.



RESULTS :

2) Three-phase feed :.



CONCLUSION :

Hence, we have studied & analyzed the performance of power converters, inverters and regenerative braking.

PRACTICAL NO: 9

Date : 24/02/2025

TITLE : To study & analyze the performance of keyless entry system in automobiles.

AIM / OBJECTIVE:
1) To understand concept of keyless entry.
2) To understand wireless entry.
3) To understand RFID concepts used in automobiles.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

UniTrain keyless Entry in Automobiles Cards (504203-6S), 504203-6T)
LN labsoft software, UniTrain Experimentes, UniTrain Interface,
Connecting wires.

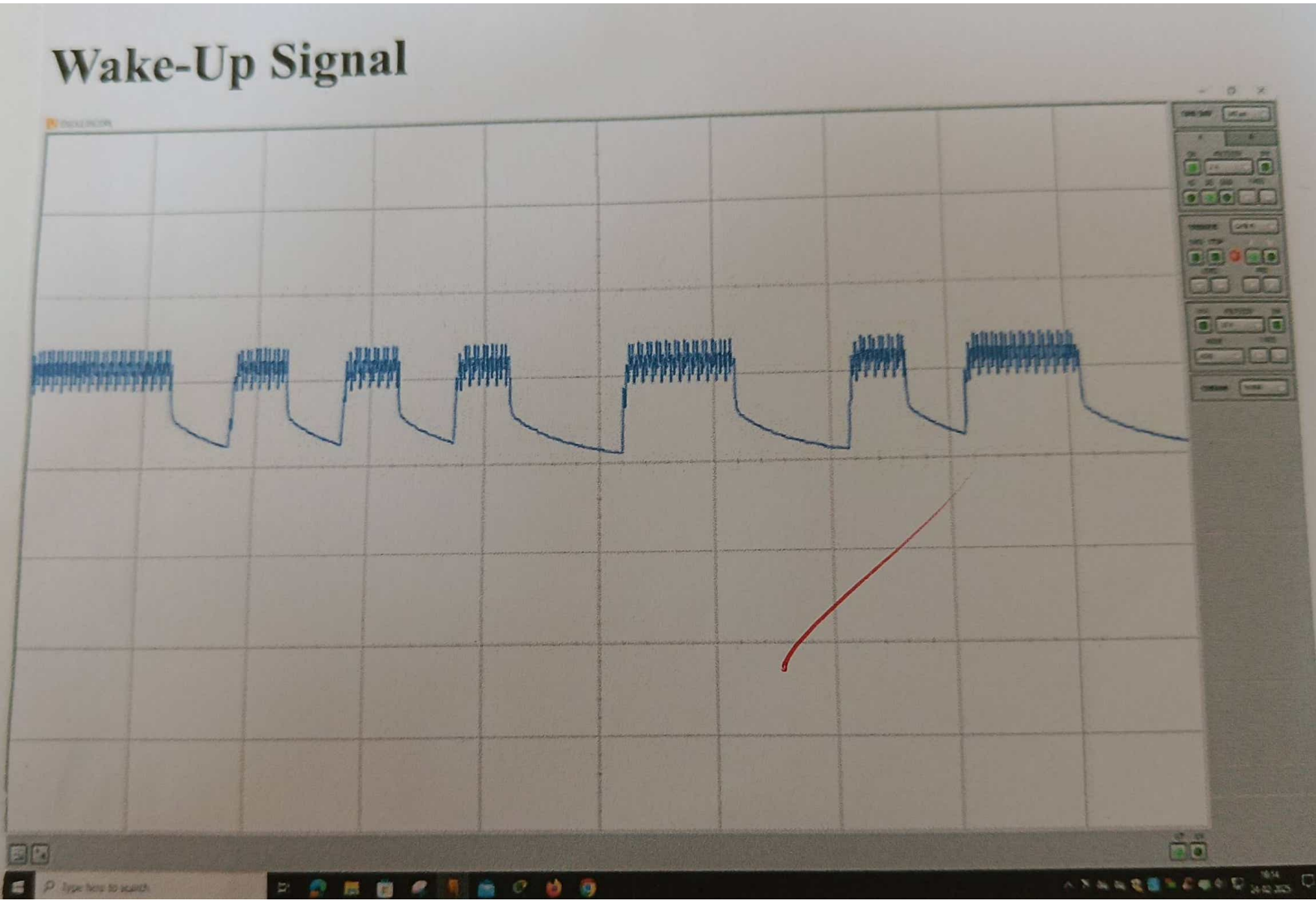
CONCEPT / THEORY OF EXPERIMENT:

Keyless entry in automobiles allows drivers to unlock & start a vehicle without a physical key a remote key fob or smartphone that communicates wirelessly with the car's system. It relies on radio frequency signals or encrypted digital codes to authetication the user and activate the locks or ignition.

PROCEDURE :

1) Open LN labsoft software and navigate the UniTrain keyless Entry Course.
2) Follow the instructions as given in the course & perform accordingly.
3) Observe the output as instructed.
4) Verify the output.

Wake-Up Signal



OBSERVATIONS

1] Keyless entry System:-

a) Vehicle key programming:-

i) Multiple keys can be designed to every vehicle.

ii) A vehicle key has to be programmed to establish communication between the key and the vehicle and to ensure that the key is able to communicate only with that particular vehicle in future.

B] Vehicle key Identification:-

i) Every key can be uniquely identified.

c] Unlocking and locking the driver's door:-

i) We are able to lock and unlock the door.

2] Design and Functions:-

a) Wake-up Signal:-

i) A signal of approximately 125 KHz is recorded.

ii) As if transmission frame is involved in this scenario.

b) Communication via high frequencies:-

i) Signal Intensity:-

a) When the key is far away from the controller the signal intensity changes notably.

b) When the key is moved away from the controller the RF signal stays ready to transmit and receive for a long time and the LF stays ready to transmit & receive for a very short time.

c] Communication Process:-

i) Car Monitor:- The seat adjustment, mirror adjustment, heater settings & steering wheel adjustment control options are represented by the car monitor.

CALCULATIONS :

2) Saving Comfort Settings:-

1) Comfort data can be saved in the transmission key.

2) Enhanced comfort is meant to improve active safety.

THEORY :-

1) Active safety :- Meant to help, prevent accidents.

Driving safety :- ASR/ISP, Precise steering, Optimal road behaviour.

Perception safety :- All-round view, Heatable windows, actural mirrors.

Condition safety :- Driver seat adjustment, Suspension, Interior Ventilation

Operational safety :- Peebil's design, arrangements of control elements, instrument

2) Passive safety :- Meant to minimize consequences of accidents.

Interior safety :- Deformation, Strong passenger compartment, fire protection.

RESULTS :

Comfort Technology :-

Central locking, Immobilizer, Electric window, Adjustable seats, Ventilation, Freating Climate control, alarm safety, adjustable external mirror, driver assistance system, mobile telephony.

CONCLUSION :

Hence, we have studied & analysed the performance of keyless entry system in automobiles

PRACTICAL NO: 10

Date : 18/04/25

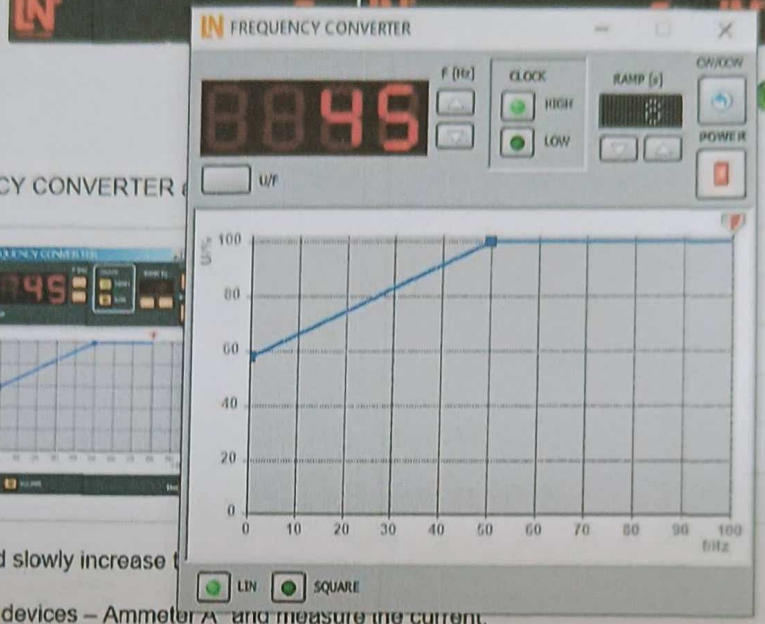
TITLE : To study & analyze the performance of various motors used in EV's.

AIM / OBJECTIVE:
1) To understand working principle of motor.
2) To know & understand working principle of different motors.
3) To understand efficiency of each motor.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:
- UniTrain Hybrid Drives - S04203-4A, S04203-4f, S04203-7T
- LN labsoft software
- UniTrain Experimenter
- Connecting wires.

CONCEPT / THEORY OF EXPERIMENT:
An electric converts electrical energy into mechanical energy by generating a magnetic field from electric current which interacts with another magnetic field to produce rotational motion. This is typically achieved using a rotor and stator with electromagnetic forces driving the motor.

PROCEDURE :
1) Open LN labsoft software and navigate to Unitrain and hybrid drives in Automobiles course.
2) Follow the instructions as given in the course & perform accordingly.
3) Observe the waveforms on oscilloscope and voltages on the virtual voltmeter.
4) Verify the Output.



Open the FREQUENCY CONVERTER

FREQUENCY CONVERT	
0 Hz	
45 Hz	
60%	
HIGH	
8 s	

Start the frequency converter and slowly increase t

Select "Instruments – Measuring devices – Ammeter A" and measure the current.

Set the measuring resistance at the ammeter's lower left corner to 1 ohm and select the "RMS" operating mode (root mean square).

Instrument:	Ammeter A
Measuring range:	2 A
Operating mode:	RMS
Shunt:	1 Ohm

What is the value of the current I_{R1}?

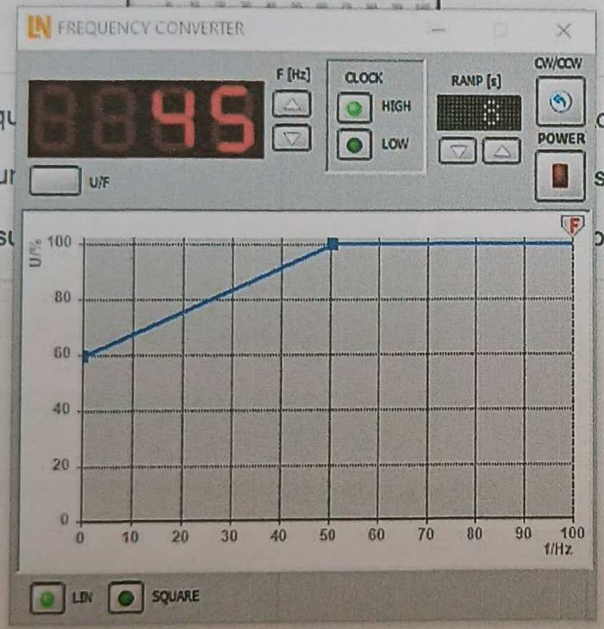
1500 mA

Correct

CHECK ANSWERS

Open the FREQUENCY CONVERTER and set the values indicated in the table below.

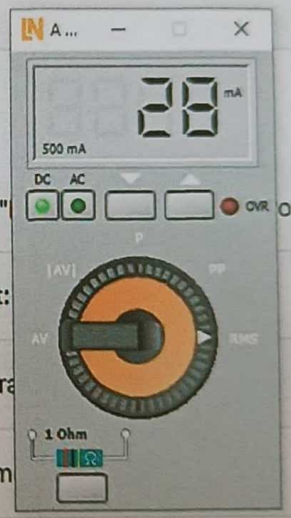
Instrument:	FREQUENCY CONVERTER
Initial frequency:	0 Hz
Final frequency:	45 Hz
Start value:	60%
CLOCK	HIGH
Ramp:	8 s



Start the frequ ... o 45 Hz.

Select "Instrur ... sure the current.

Set the measu ... o 1 ohm and select the "... oot mean square).



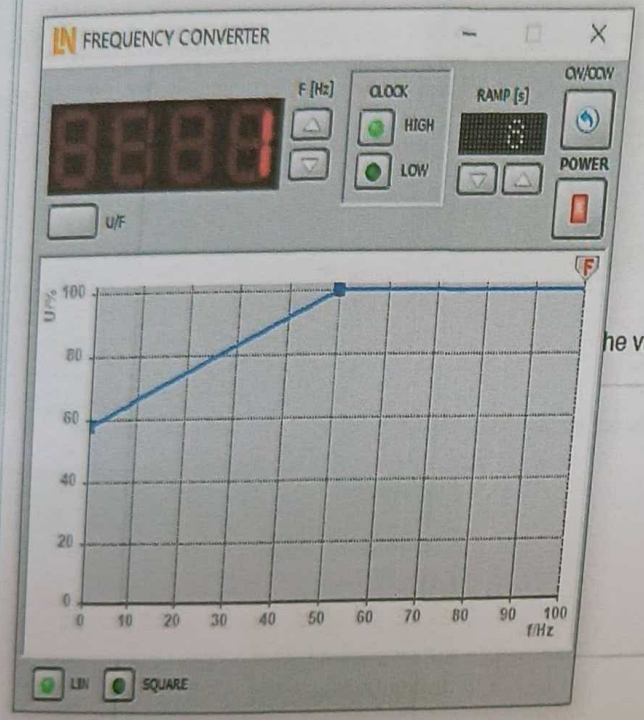
Instrument:	Ammeter A
Measuring ra	1 A
Operating m	RMS
Shunt:	1 ohm

What is the value of the current I_{R1}?

500 mA

Correct

CHECK ANSWERS



he values shown in the table below.

Instrument:	FREQUENCY CONVERTER
Frequency:	0 Hz
CLOCK	HIGH
Ramp:	8 s

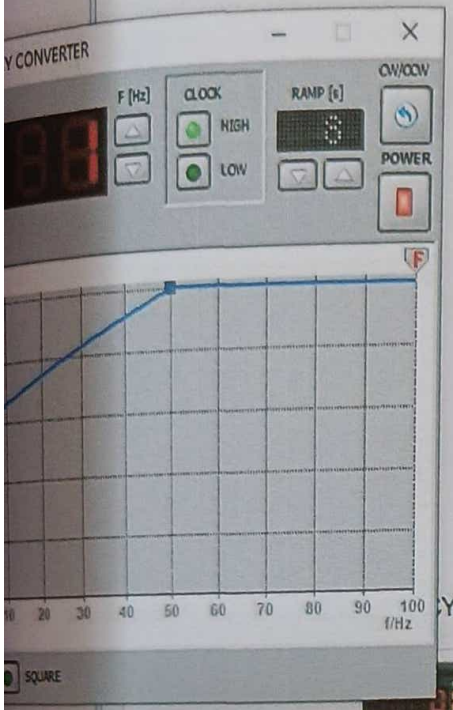
Start the frequency converter and increase the frequency to 1 Hz.

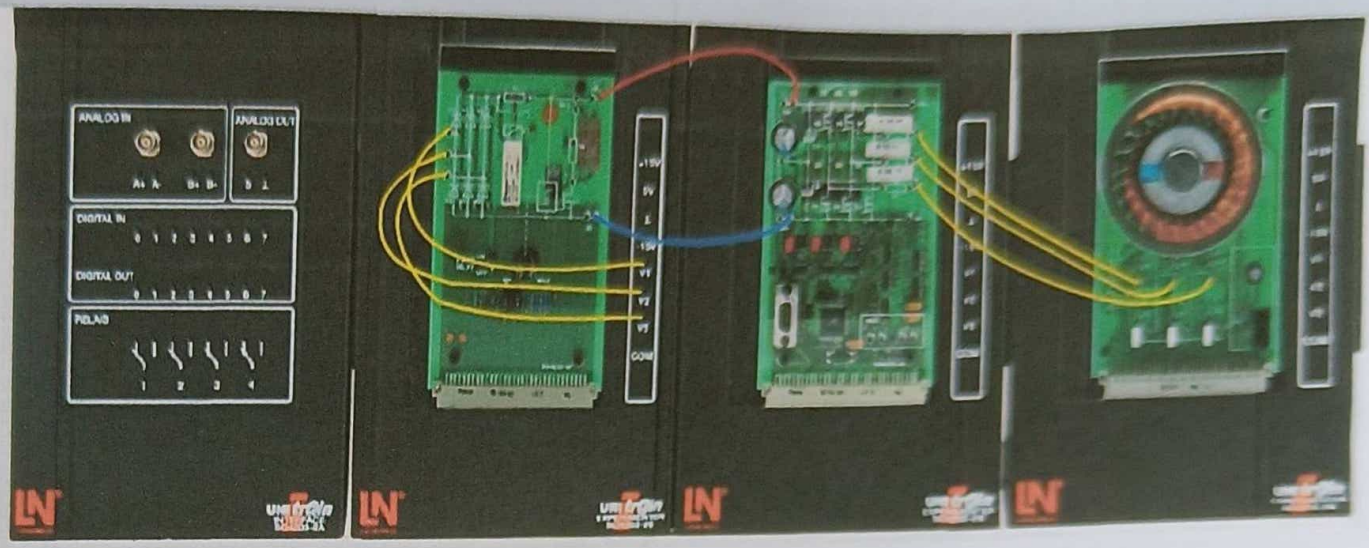
How does the rotor behave on starting?

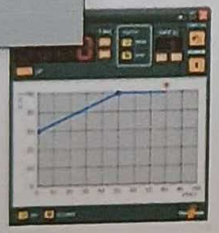
- ○ The rotor does not start.
- ○ The rotor jerks.
- ◉ The rotor starts smoothly.

Correct

CHECK ANSWERS







Y CONVERTER and set the values shown in the table below.

Instrument:	FREQUENCY CONVERTER
Frequency:	0 Hz
CLOCK	HIGH
Ramp:	8 s

Start the frequency converter and increase the frequency to 1 Hz.

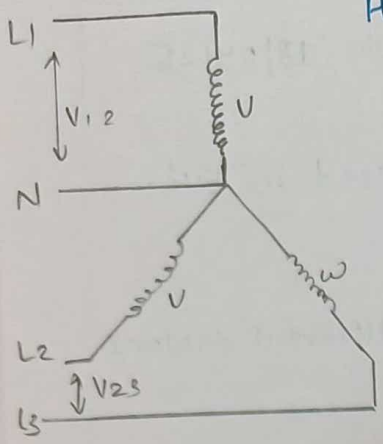
How does the rotor behave on starting?

- ○ The rotor does not start.
- ◉ The rotor jerks.
- ○ The rotor starts smoothly.

Correct

CHECK ANSWERS

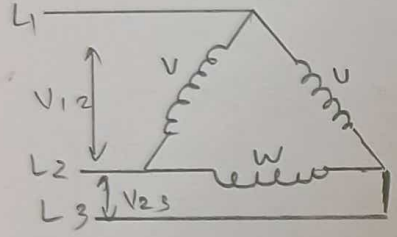
1) Star Connection :-



Here, 1) Phase voltage (V_p) = $\sqrt{3}$ line voltage.

2) Phase Current (I_p) = line current (I_L)

2) Delta Connection :-



Here, 1) phase voltage (V_p) = line voltage

2) Phase current (I_p) = $\sqrt{3}$ line current.

Theory :-

1) Electric Machine (Motor) :-

An electric machine comprises of a stationary part (Stator) and a rotary part (rotor).

- Stator :- The stator is the stationary part of the electric motor and is responsible for producing the rotating magnetic fields. It is made up of several energized coils & package of stator laminations are needed for this purpose.

- Rotor : The rotor is mounted on the motor shaft which transfers the torque to the machine. Rotors come in designs which ultimately determine the three-phase machines type & operational characteristics : with or without coils, with or without slip rings, squrrel-cage, permanent magned.

Each electric field is phase shifted by 120°. Hence, the magnetic field space vector of each field is at 120° phase difference with respect to the next.

Now, these magnetic fields are present inside the stator & hence due to three phase electric field rotating.

The Stator winding is connected in delta or star configuration.

OBSERVATIONS

1) Electric Machine Design :-

a) Star Connection's current consumption.

i) The value of current IRL is 530mA.

b) Delta Connection's current consumption

i) The value of current IRL is 1800 mA.

c) Rotation reversal :-

i) At 45Hz the machine rotates clockwise.

2) At 45Hz but connections reversed the machine rotates anticlockwise.

3) At 45Hz connections reversed and CW/CCW pressed the machine rotates clockwise as the change in control configuration has the same effect as interchanging two phases.

2] Synchronous Machine :-

a) Starting a squerell cage motor :

• The motor starts smoothly.

b) Starting a permanent magnet rotor

• The rotor jerks on start.

THEORY :-

2) Asynchronous Machine :- An asynchronous machine's rotor can have a squirrel cage or slip ring design. This type of rotor comprises a number of conductors short circuited at both ends by means of a conductive ring.

A Squirrel cage rotor has 1) shaft

2) A pacakage of mutually insulated dynamoplates with prepared cavities for accomodating the rotor bars.

CALCULATIONS :

3) Aluminium, rotor bars, and short circuit rings.

If a machine operates under no load, the idle speed approximates the synchronous speed.

$$\text{Slip}(s) = \frac{no - n}{ho}$$

3] Synchronous Machine :-

A synchronous machine rotor turns syncronously with the field i.e at the same speed as the field.

A rotor with permanent extraction has a permanent magnet fitted in the rotor.

RESULTS :

CONCLUSION :

Hence, we have studied & analyzed the performance of various motors used in EV's.