

The Project of Capacity Building for Industry Demand-based TVET in Uganda

In-service Training Program (Manual) for Instructors

Automotive

January, 2025



Contents

Day	Activity		Details
Day 1	Job Sheet 1	Automotive Electrical System	➤ Automotive Electrical System ➤ Wiring Harness of Automotive ➤ Harness Layout of Automotive
Day 2	Job Sheet 2	Main Harness & Engine Harness Circuit	➤ Main Harness & Engine Harness ➤ Analyze the harness connectors ➤ Find the component locations
Day 3	Job Sheet 3	Control Harness & Extra Harness	➤ Control Harness & Extra Harness ➤ Analyze the harness connectors ➤ Find the component
Day 4	Job Sheet 4	Starting System & Lamp System Circuit	➤ Analyze circuit diagram ➤ Inspect power line including fuses, relays ➤ Inspect ignition switch
Day 5	Job Sheet 5	Power Door Lock, Power Window, Wiper & Washer Circuit	➤ Analyze circuit diagram ➤ Inspect power line including fuses, relays ➤ Inspect input voltage to the motors
Day 6	Job Sheet 6	Power Distribution of Automotive Electrical System	➤ Analyze circuit diagram ➤ Inspect power line including fuses, relays ➤ Combine circuit diagram pages ➤ Draw power flow line
Day 7	Job Sheet 7	Eco-friendly Car	➤ Understand the background of the development of eco-friendly cars. ➤ Classify the types of eco-friendly cars.
Day 8	Job Sheet 8	Battery Electric Vehicle	➤ Diagnose high voltage battery ➤ Diagnose power conversion devices
Day 9	Job Sheet 9	Hybrid Electric Vehicle	➤ Diagnose high voltage battery ➤ Diagnose power conversion devices
Day 10	Job Sheet 10	FCEV(Fuel Cell Electric Vehicle)	➤ Understand the operating principles of hydrogen FCEV ➤ Explain the components of FCEV.

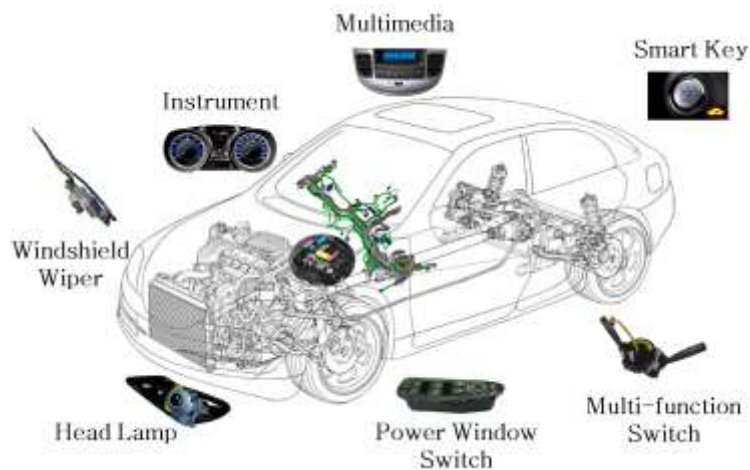
Job Sheet 1

Day	1	Task No.		Time	8h
Title	Automotive Electrical System				
Material	Name		Specification	Q'ty	
	Test Lamp		LED	1	
	Circuit Tester		With Beep	1	
	Electrical Troubleshooting Manual		Avante	1	

1. Purpose

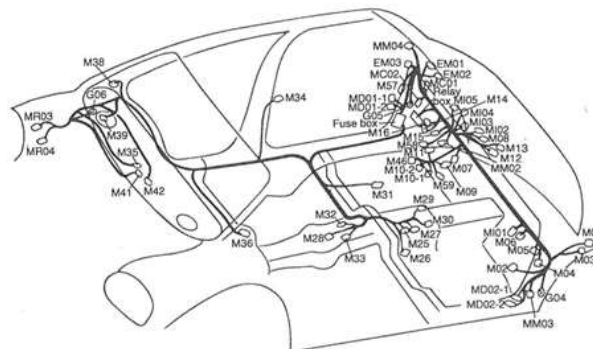
- After completing this practice, the student should be able to:
 - Explain component of automotive electrical system
 - Explain harness layout
 - Analysis the circuit diagram

2. Job Figures: Component of Automotive Electrical System

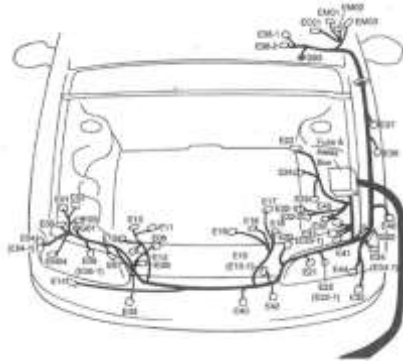


3. Layout of Automotive Harness

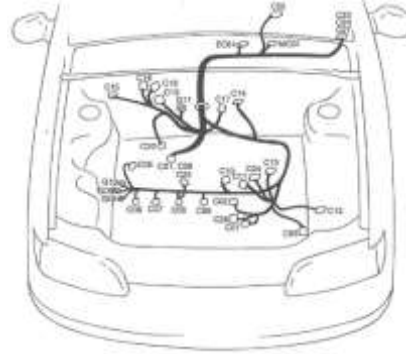
3.1 Main Harness



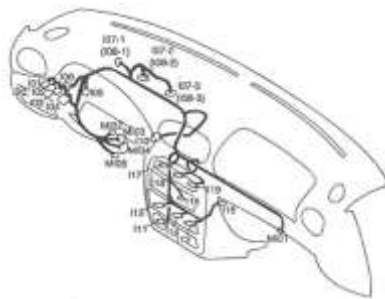
3.2 Engine Harness



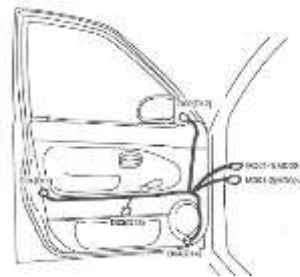
3.3 Control Harness



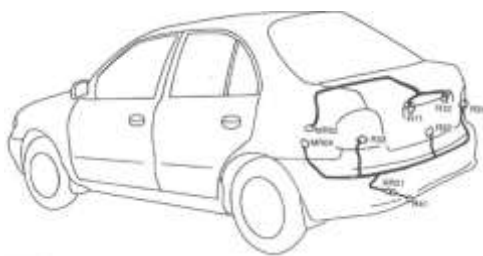
3.4 Instrument Harness



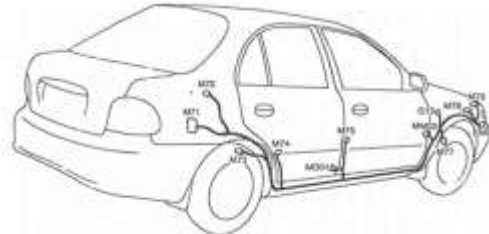
3.5 Door Harness



3.6 Rear Harness



3.7 Main Extension Harness



- Information: Electrical Troubleshooting Manual

- Requirements: Analysis harness layout

Job Sheet 2

Day	2	Task No.		Time	8h
Title	Main Harness & Engine Harness Circuit				
Material	Name		Spec	Q'ty	
	Test Lamp		LED	1	
	Circuit Tester		With Beep	1	
	Electrical Troubleshooting Manual		Avante	1	

1. Purpose

- After completing this practice, the student should be able to:
 - Explain the Main & Engine Harness and connectors
 - Classify the usage of connectors and terminals
 - Explain the function of every connectors of Main & Engine Harness

2. Job Figures

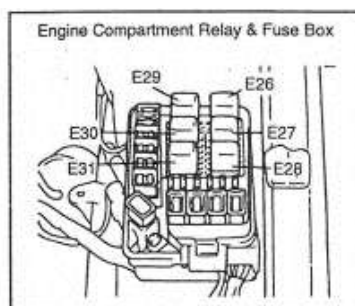
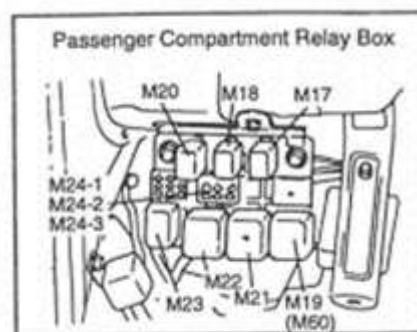
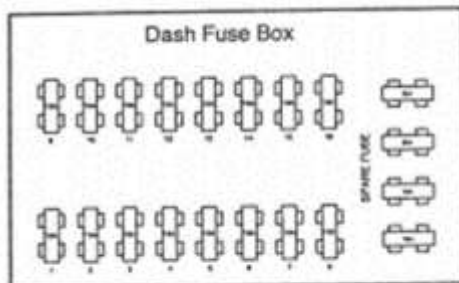
MAIN HARNESS

HL-3

M01	Side Repeater Lamp (RH)	M35	Fuel Tank Pressure Sensor (NAS)
M02	Power Antenna	M36	Fuel Sender
M03	A/T Interlock Control Module	M38	Rear Wheel Sensor (LH, ABS)
M04	Blower Resistor	M39	Rear Speaker (LH)
M05	Blower Motor	M41	Trunk Room Lamp
M06	Thermo Switch (with Thermistor)	M42	High Mounted Stop Lamp
M07	Chime Bell	M46	A/T Key Interlock Solenoid
M08	Seat Belt Timer	M57	Front Fog Lamp Relay (With Carburetor)
M09	Door Warning Switch	M58	Immobilizer Control Module
M10-1	Multifunction Switch	M59	Antenna Coil
M10-2	Multifunction Switch	M60	Front Fog Lamp Relay
M11	Ignition Switch	EM01	Connection With ENGINE Harness
M12	Acoustic Warning Chime Buzzer	EM02	Connection With ENGINE Harness
M13	Rear Defogger Timer	EM03	Connection With ENGINE Harness
M14	Starter Clutch Pedal Position Switch	MC01	Connection With CONTROL Harness
M15	Intermittent Wiper Relay	MC02	Connection With CONTROL Harness
M16	Stop Lamp Switch	MD01-1	Connection With LH FRONT DOOR Har- ness
M17	Starter Relay	MD01-2	Connection With LH FRONT DOOR Har- ness
M18	Fuel Pump Relay	MD02-1	Connection With RH FRONT DOOR Har- ness
M19	Fuel Pump Control Relay	MD02-2	Connection With RH FRONT DOOR Har- ness
M20	Rear Fog Lamp Relay		
M21	Flasher Unit		
M22	Power Window Relay		
M23	Blower Relay		
M24-1	Joint Connector	MI01	Connection With INSTRUMENT Harness
M24-2	Joint Connector	MI02	Connection With INSTRUMENT Harness
M24-3	Joint Connector	MI03	Connection With INSTRUMENT Harness
M25	A/T Shift Lever	MI04	Connection With INSTRUMENT Harness
M26	Seat Warmer (RH)	MI05	Connection With INSTRUMENT Harness
M27	Seat Warmer Switch (RH)	MM02	Connection With AIR BAG Harness
M28	Parking Brake Switch	MM03	Connection With ABS Harness
M29	Power Window Switch	MM04	Connection With ROOF Harness
M30	Seat Warmer Switch (LH)	MR03	Connection With REAR Harness
M31	Rear Heated Oxygen Sensor (NAS)	MR04	Connection With REAR Harness
M32	Seat Warmer (LH)	GROUND	G04
M33	Seat Belt Switch	GROUND	G05
M34	Front Door Switch (LH)	GROUND	G06

Engine Harness

E01	Front Washer Motor	E26	Radiator Fan Relay
E02	Rear Washer Motor	E27	Head Lamp Relay
E03	Head Lamp Washer Motor	E28	Air Conditioning Relay
E04	Turn Signal Lamp (RH)	E29	Horn Relay
E04-1	Turn Signal Lamp (RH) (NAS)	E30	Tail Lamp Relay
E05	ABS Relay Box	E31	Condenser Fan Relay
E06	Head Lamp (RH)	E32	Battery Cable
E06-1	Head Lamp (RH) (NAS)	E32-1	Starter Motor Solenoid
E07	Head Lamp Leveling Actuator (RH)	E32-2	Starter motor
E08	A/C Pressure Switch	E33	DRL Control Module
E09	Condenser Fan motor	E33-1	Dim Dip Device
E10	Engine Coolant Temperature Sensor (Without Carburetor)	E34	Turn Signal Lamp (LH)
E11	Engine Coolant Temperature Sender (NAS)	E34-1	Turn Signal Lamp (LH) (NAS)
E12	Generator (L, R)	E35	Horn (LH)
E13	Generator (B+)	E36	Front Wheel Sensor (LH, ABS)
E14	Horn (RH)	E37	Side Repeater Lamp (LH)
E15	Radiator Fan Motor (Without Carburetor)	E38-1	Transaxle Control Module (TCM)
E15-1	Radiator Fan Motor (With Carburetor)	E38-2	Transaxle Control Module (TCM)
E16	Pulse Generator	E40	DRL Resistor
E17	A/T Solenoid	E41	DRL Relay
E18	Transaxle Range Switch	E42	Front Fog Lamp (LH)
E19	Oil Temperature Sensor	E43	Front Fog Lamp (RH)
E20	Head Lamp Washer Relay	E44	Canister Close Valve
E21	Head Lamp Leveling Actuator (LH)	EC01	Connection With CONTROL Harness
E22	Head Lamp (LH)	EM01	Connection With MAIN Harness
E22-1	Head Lamp (LH) (NAS)	EM02	Connection With MAIN Harness
E23	Brake Fluid Level Sensor	EM03	Connection With MAIN Harness
E24	Intake Air Temperature Sensor (Without Carburetor)	EM04	Connection With ABS Harness
E25	Purge Control Solenoid Valve	GROUND G01	
		GROUND G02	
		GROUND G03	



□ Information: Electrical Troubleshooting Manual

□ Requirements: Analysis harness connectors

Job Sheet 3

Day	3	Task No.		Time	8h
Title	Control Harness & Extra Harness				
Material	Name		Specification	Q'ty	
	Test Lamp		LED	1	
	Circuit Tester		With Beep	1	
	Electrical Troubleshooting Manual		Avante	1	

1. Purpose

- After completing this practice, the student should be able to:
 - Explain the Control & Extra Harness and connectors
 - Classify the usage of connectors and terminals
 - Explain the function of every connectors of Control Harness

2. Job Figures: Connector Name(SOHC)

C01	Crankshaft Position (CKP) Sensor	C19	Pre-excitation resistor
C02	Oil Pressure switch	C20	Knock Sensor
C03	Back-up Lamp Switch (M/T)	C21	Front Heated Oxygen Sensor (Except NAS)
C04	Camshaft Position (CMP) Sensor	C22	MFI Control Relay
C05	A/C Compressor	C23	ECM (1.3 Siemens)
C06	Injector #1	C24	ECM (Except NAS, With 1.5 Bosch)
C07	Injector #2	C25	Idle Speed Actuator (ISA)
C08	Injector #3	C27	ECM (NAS)
C09	Injector #4	C28	Front Heated Oxygen Sensor (NAS)
C10	Throttle Position (TP) Sensor	C29	Rear Heated Oxygen Sensor (CAL)
C11	Ignition Coil	C30	Acceleration sensor (NAS)
C12	Mass Air Flow (MAF) Sensor	EC01	Connection With ENGINE Harness
C13	Kick Down Switch (A/T)	MC01	Connection With MAIN Harness
C14	Idle Switch (A/T)	GROUND	G08
C15	Wiper Motor	GROUND	G09
C16	Manifold Absolute Pressure (MAP) Sensor	GROUND	G10
C17	Fuel Pump Checker	GROUND	G11
C18	Variable Resistor		

3. Job Figures: Connector Name(DOHC)

C31	Crankshaft Position (CKP) Sensor	C50	Engine Coolant Temperature Sender
C32	Oil Pressure Switch	C51	Front Heated Oxygen Sensor (NAS, SWE-DEN)
C33	Back up Lamp Switch (M/T)	C51-1	Heated Oxygen Sensor
C34	Camshaft Position (CMP) Sensor	C52	MFI Control Relay
C35	A/C Compressor	C53	ECM (NAS, SWEDEN)
C36	Injector #1	C54	ECM
C37	Injector #2	C55	Idle Speed Actuator
C38	Injector #3	C56	Manifold Absolute Pressure (MAP) Sensor
C39	Injector #4	C57	Acceleration Sensor (NAS, SWEDEN)
C40	Throttle Position (TP) Sensor	C58	Condenser
C41	Ignition Coil	C59	Knock Sensor
C41-1	Ignition Coil	EC01	Connection with ENGINE Harness
C42	Mass Air Flow (MAF) Sensor	MC01	Connection with MAIN Harness
C43	Kick Down switch (A/T)	MC02	Connection with MAIN Harness (NAS)
C44	Idle Switch (A/T)	GROUND	G16
C45	Wiper Motor	GROUND	G17
C46	Engine Coolant Temperature Sensor	GROUND	G18
C47	Fuel Pump Checker		
C49	Pre-excitation resistor		

4. Job Figures: Connector Name(Carburetor)

C70-1	Ignition Coil	C75	A/C Compressor
C70-2	Ignition Coil	C76	Pre-excitation resistor
C70-3	Ignition Coil	C77	Oil Pressure Switch
C71	Back up Lamp Switch	EC01	Connection With ENGINE Harness
C72	Fuel Cut Solenoid	MC01	Connection With MAIN Harness
C73	Wiper Motor	GROUND	G12
C74	Idle up Solenoid		

5. Job Figures: Connector Name(Instrument Harness)

I01	Rear Fog Lamp Switch	I12	Blower Switch
I02	Head Lamp Wahser Switch	I13	Air Conditioning Switch
I03	Rheostat	I14	Blower Control
I04	Head Lamp Leveling Switch	I15	Joint Connector
I05	Power Door Mirror Switch	I16	Audio
I06	Data Link Connector	I17	Rear Washer Switch (3/5DR Only)
I07-1	Instrument Cluster	I18	Digital Clock
I07-2	Instrument Cluster	I19	Hazard Switch
I07-3	Instrument Cluster	I20	Front Fog Lamp switch
I08-1	Instrument Cluster (Deluxe)	MI01	Connection With MAIN Harness
I08-2	Instrument Cluster (Deluxe)	MI02	Connection With MAIN Harness
I08-3	Instrument Cluster (Deluxe)	MI03	Connection With MAIN Harness
I10	Rear Defogger Switch	MI04	Connection With MAIN Harness
I11	Cigarette Lighter	MI05	Connection With MAIN Harness

6. Job Figures: Connector Name(Door Harness)

D01	Front Door Lock Actuator (LH)	D04	Front Speaker (LH)
D11	Front Door Lock Actuator (RH)	D14	Front Speaker (RH)
D02	Power Door Mirror Motor (LH)	MD01-1	Connection With LH MAIN Harness
D12	Power Door Mirror Motor (RH)	MD01-2	Connection With LH MAIN Harness
D03	Front Power Window Motor (LH)	MD02-1	Connection With RH MAIN Harness
D13	Front Power Window Motor (RH)	MD02-2	Connection With RH MAIN Harness

7. Job Figures: Connector Name(Main Extension)

M71	ABS Control Module	M79	ABS Relay Box
M72	Rear Speaker (RH, 3/5DR Only)	MD01	Connection With RH REAR DOOR Harness (4/5DR Only)
M73	Rear Wheel Sensor (RH)	EM04	Connection With ENGINE Harness
M74	Rear Door Switch (RH, 4/5DR Only)	MM03	Connection With MAIN Harness
M75	Front Door Switch	GROUND	G13
M77	Front Wheel Sensor (RH)		
M78	ABS Modulator		

8. Job Figures: Connector Name(Rear Harness)

R11	License Lamp (LH) (4 Door only)	MR02	Connection With MAIN Harness (4 Door only)
R12	License Lamp (RH) (4 Door only)	MR04	Connection With MAIN Harness
R31	Rear Combination Lamp (RH)	RR01	Connection With REAR FOG LAMP Harness
R32	Trunk Room Lamp Switch		
R33	Rear Combination Lamp (LH)		
R41	Rear Fog Lamp (RH)		

□ Information: Electrical Troubleshooting Manual

□ Requirements: Analysis harness connectors

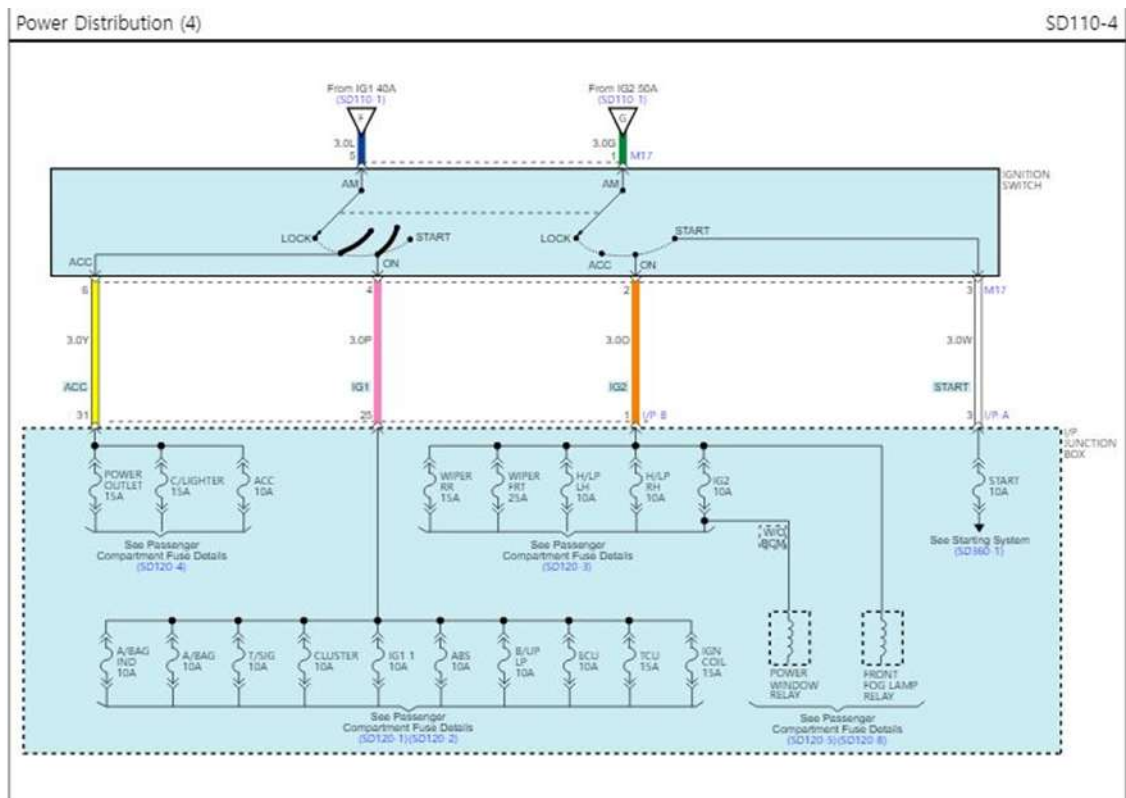
Job Sheet 4

Day	4	Task No.		Time	8h
Title	Starting System & Lamp System Circuit				
Material	Name	Spec	Q'ty		
	Test Lamp	LED	1		
	Circuit Tester	With Beep	1		
	Electrical Troubleshooting Manual	Avante	1		

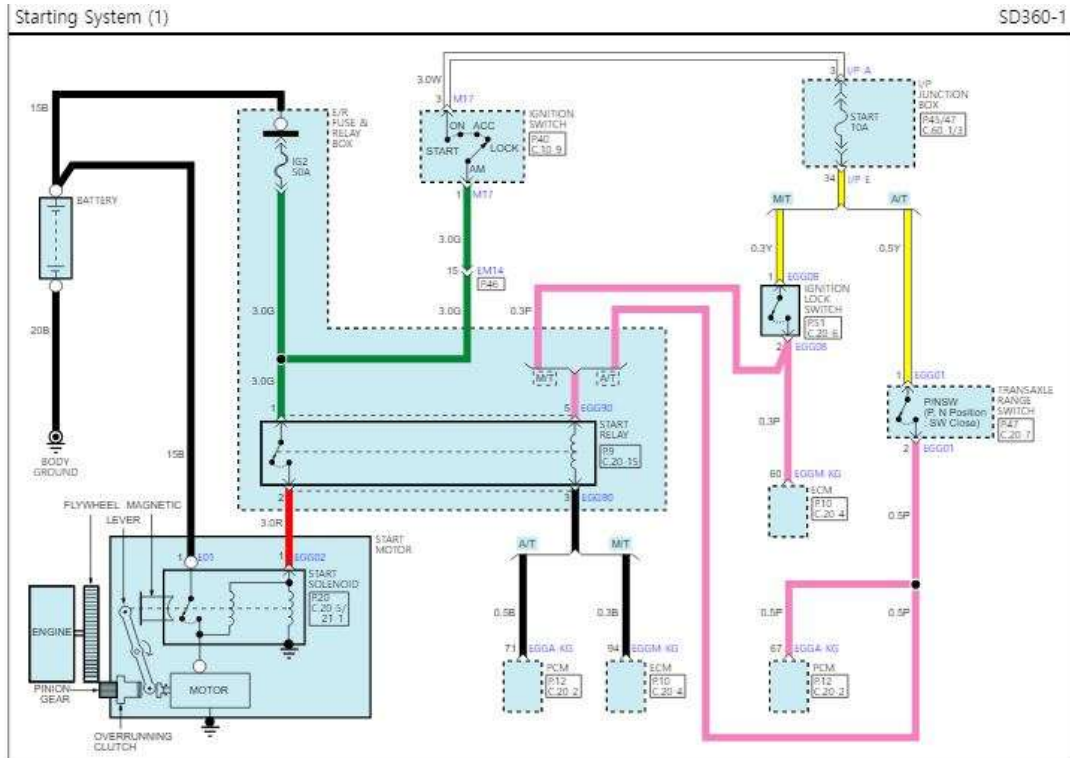
1. Purpose

- After completing this practice, the student should be able to:
 - Explain the function of Ignition Switch, Starting & Lamp System
 - Analyze the circuit diagram of Ignition Switch, Starting & Lamp System
 - Troubleshoot the faults of Ignition Switch, Starting & Lamp System

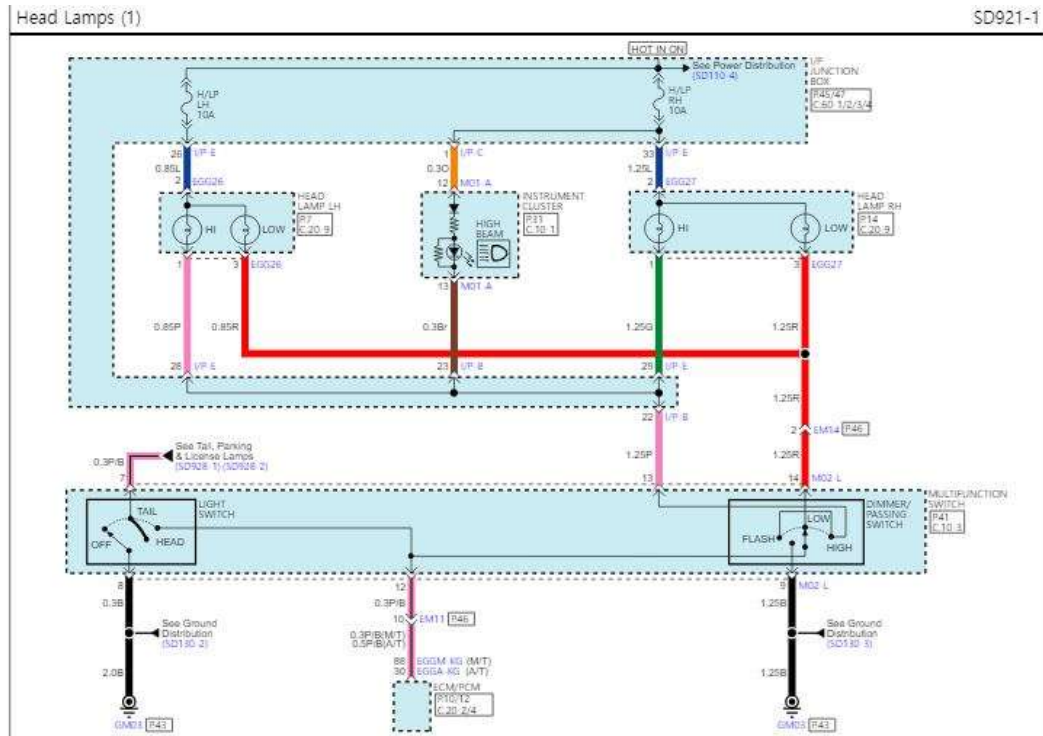
2. Job Figures(Ignition Switch Circuit)



3. Job Figures(Starting System Circuit)



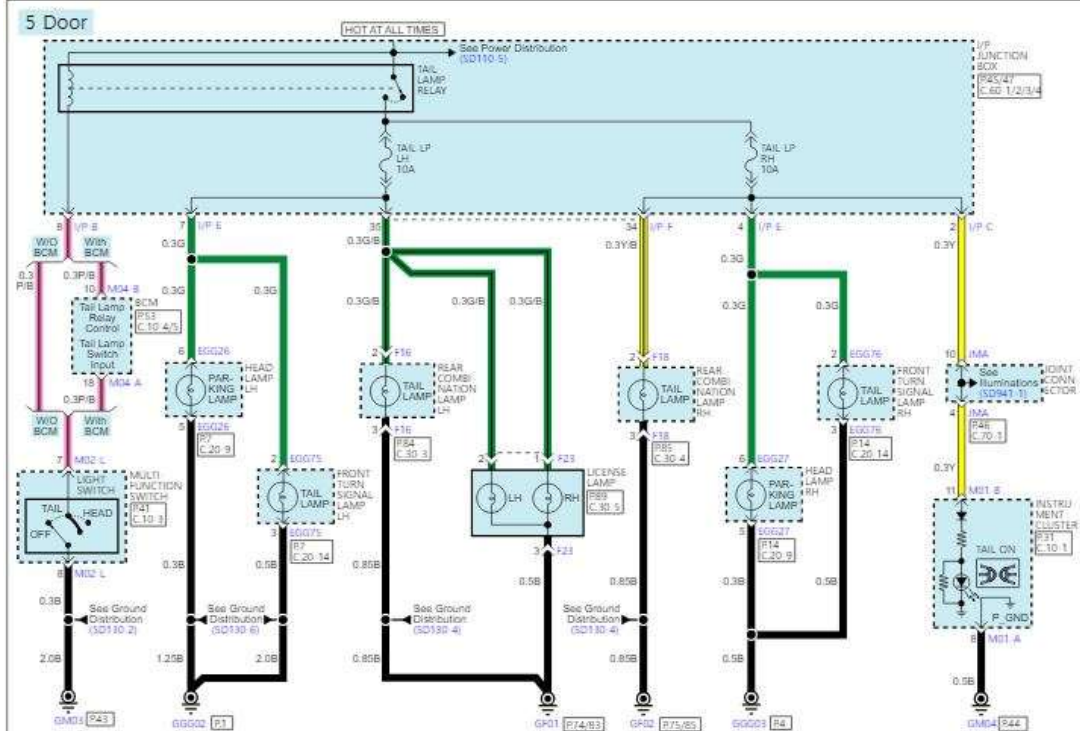
4. Job Figures(Head Lamp Circuit)



5. Job Figures(Tail, Parking & License Lamp Circuit)

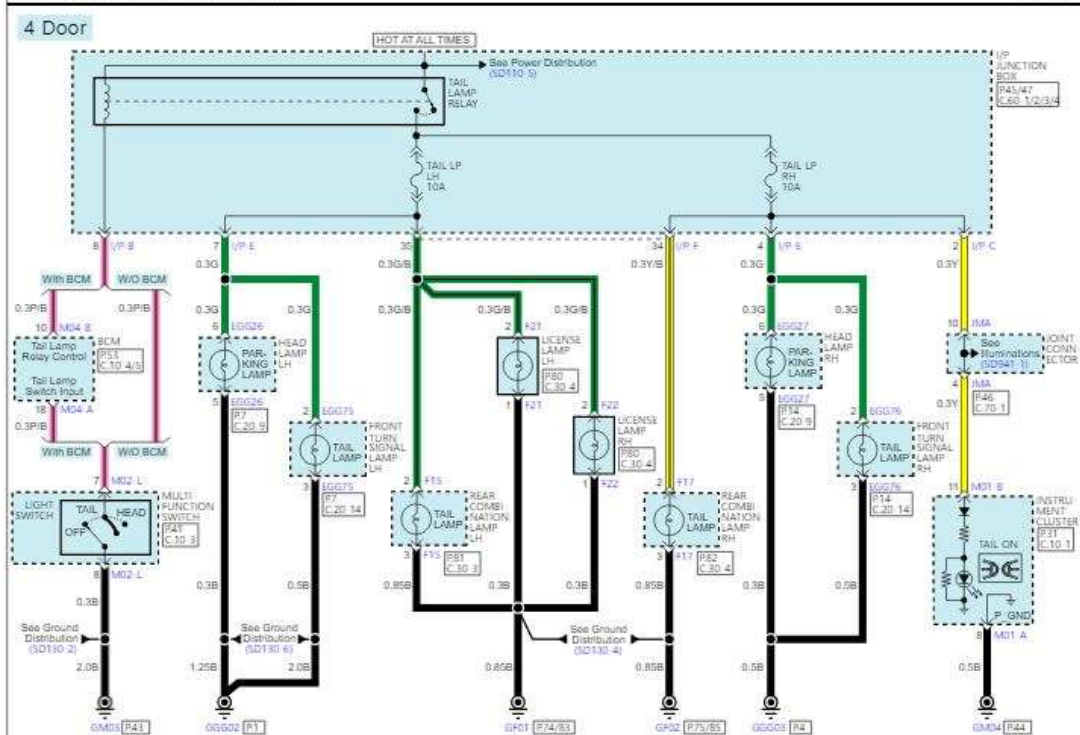
Tail, Parking & License Lamps (2)

SD928-2



Tail, Parking & License Lamps (1)

SD928-1



□ Information: Electrical Troubleshooting Manual

□ Requirements: Analysis electrical circuit diagram

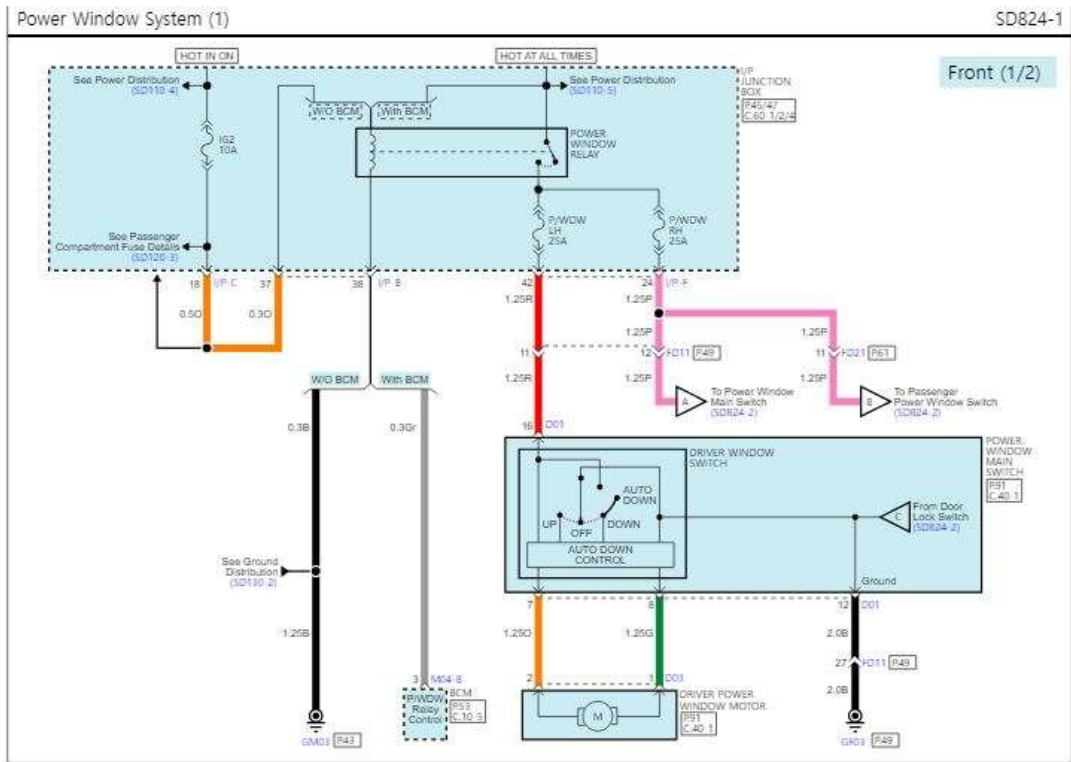
Job Sheet 5

Day	5	Task No.		Time	8h
Title	Power Door Lock, Power Window, Wiper & Washer Circuit				
Material	Name		Specification	Q'ty	
	Test Lamp		LED	1	
	Circuit Tester		With Beep	1	
	Electrical Troubleshooting Manual		Avante	1	

1. Purpose

- After completing this practice, the student should be able to:
 - Explain the function of Power Window and Door Lock circuit
 - Analyze the circuit diagram of Power Window and Door Lock circuit
 - Troubleshoot the faults of Power Window and Door Lock circuit

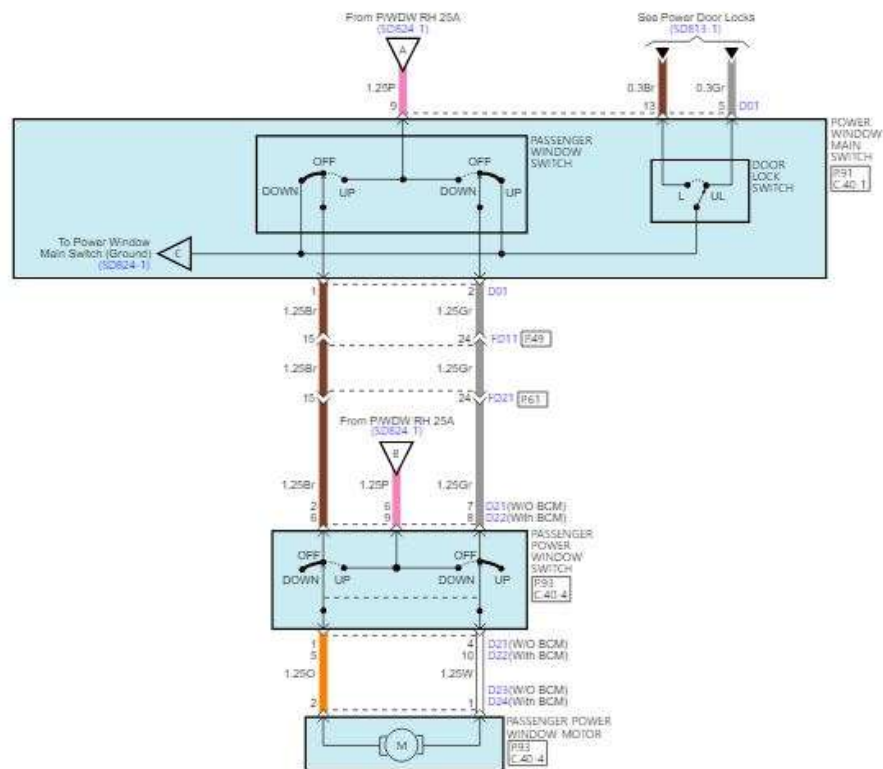
2. Job Figures(Power Window 1)



3. Job Figures(Power Window 2)

Power Window System (2)

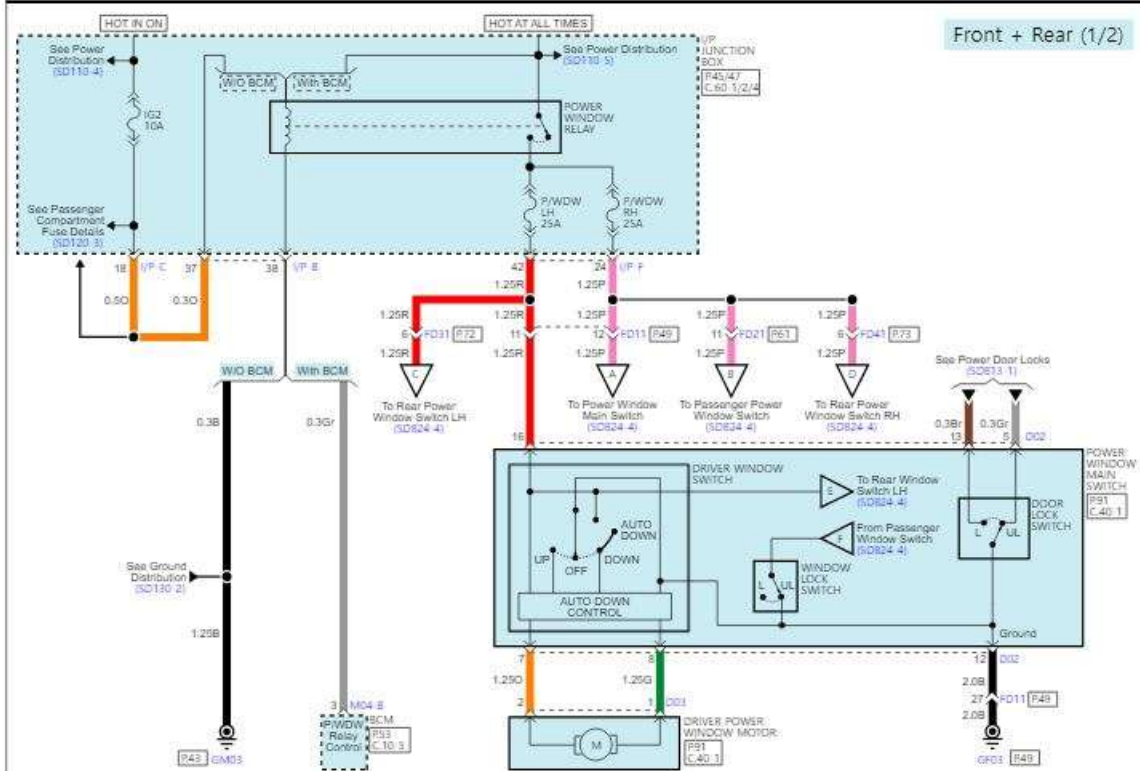
SD824-2



4. Job Figures(Power Window 3)

Power Window System (3)

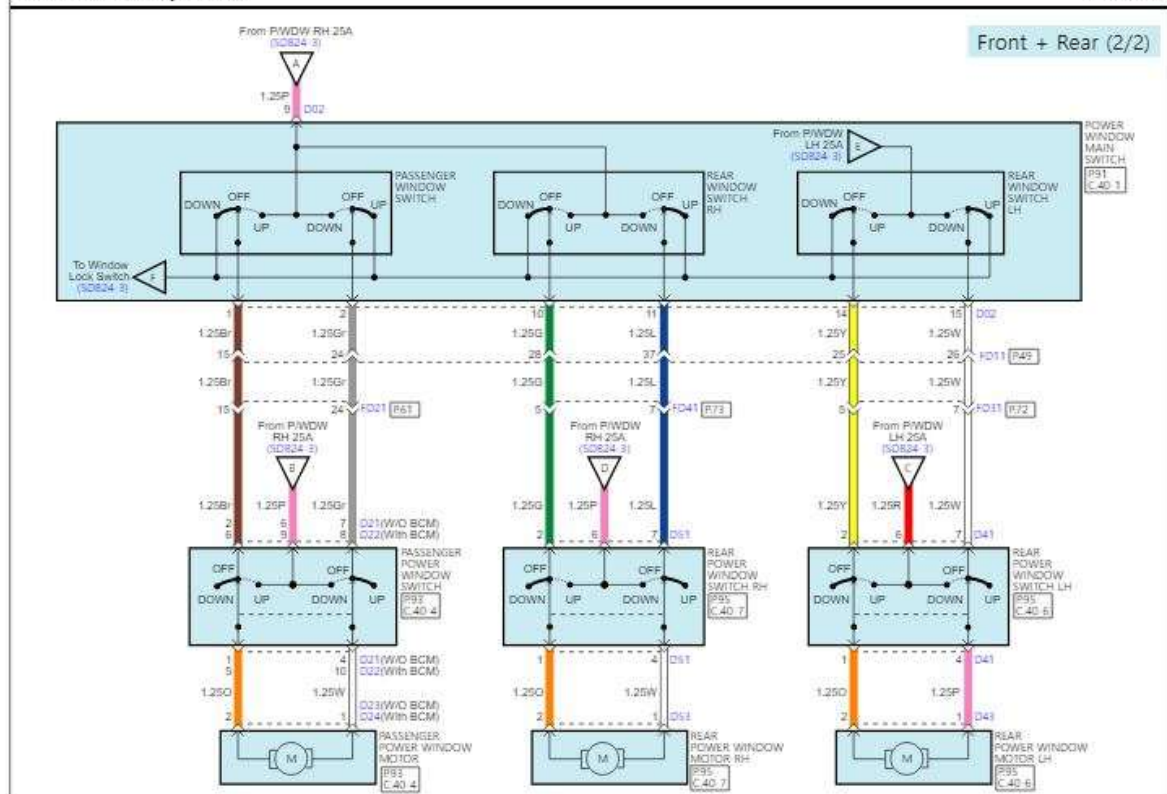
SD824-3



5. Job Figures(Power Window 4)

Power Window System (4)

SD824-4



- Information: Electrical Troubleshooting Manual
- Requirements: : Analysis electrical circuit diagram

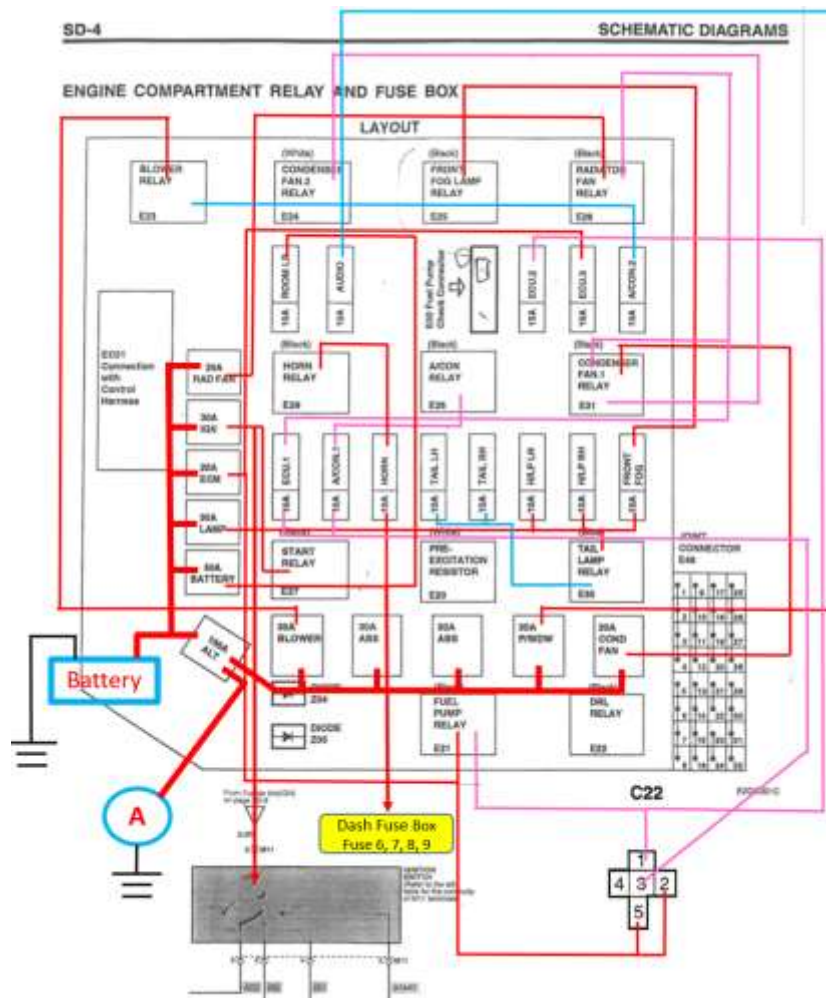
Job Sheet 6

Day	6	Task No.		Time	8h
Title	Power Distribution of Automotive Electrical System				
Material	Name	Spec	Q'ty		
	Test Lamp	LED	1		
	Circuit Tester	With Beep	1		
	Electrical Troubleshooting Manual	Avante	1		

1. Purpose

- After completing this practice, the student should be able to:
 - Analyze circuit diagram
 - Inspect power line including fuses, relays
 - Combine circuit diagram pages
 - Draw power flow line

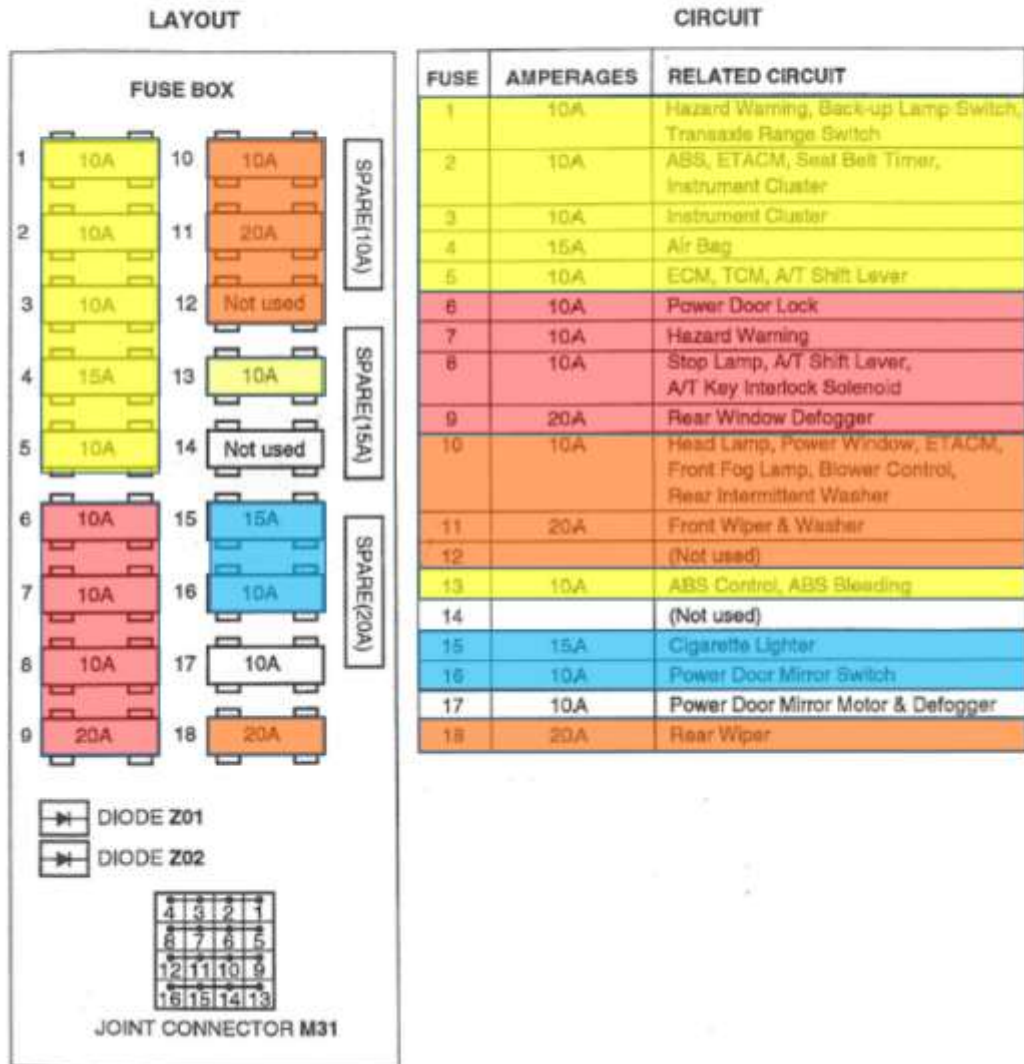
2. Job Figures 1



3. Job Figures 2

FUSE AND RELAY INFORMATION ESP0C0010

DASH FUSE BOX



□ Information: Electrical Troubleshooting Manual

□ Requirements: : Analysis electrical circuit diagram

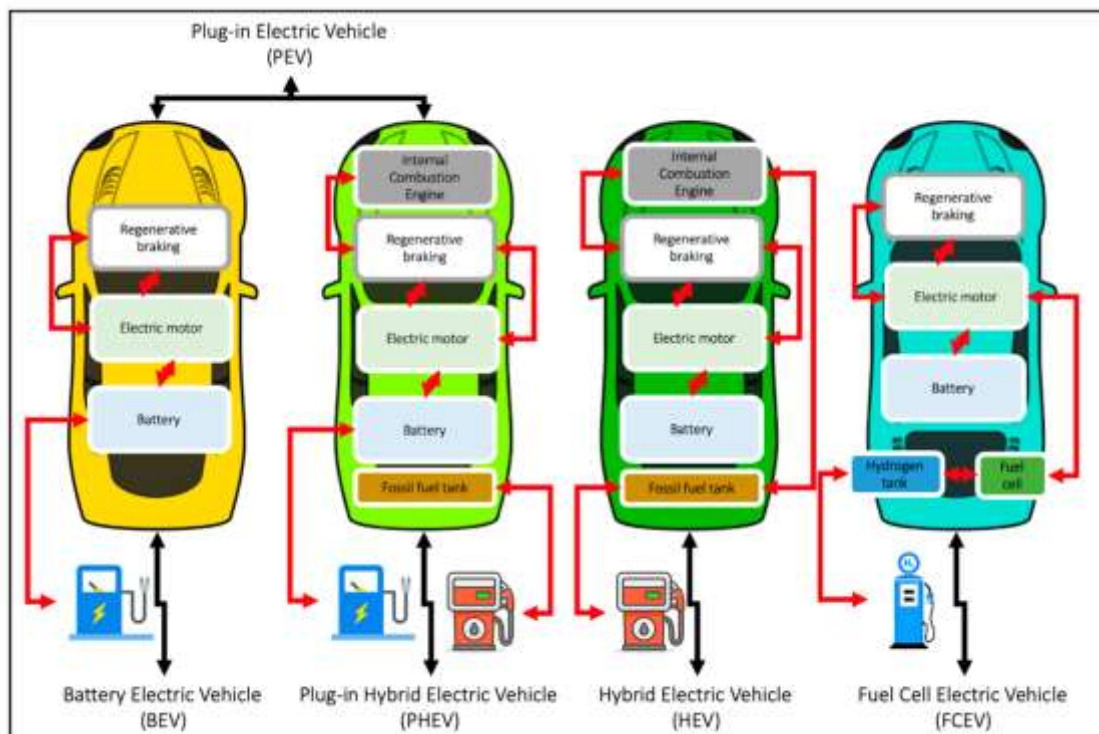
Job Sheet 7

Day	7	Task No.		Time	8h
Title	Eco-friendly Car				
Material	Name		Specification	Q'ty	
	Test Lamp		LED	1	
	Circuit Tester		With Beep	1	
	Electrical Troubleshooting Manual		EV6	1	

1. Purpose

- After completing this practice, the student should be able to:
 - Understand the background of the development of eco-friendly cars.
 - Classify the types of eco-friendly cars.

2. Job Figures



□ Information: <https://www.mdpi.com/2413-8851/4/4/57>

□ Requirements: Analysis types of eco-friendly car

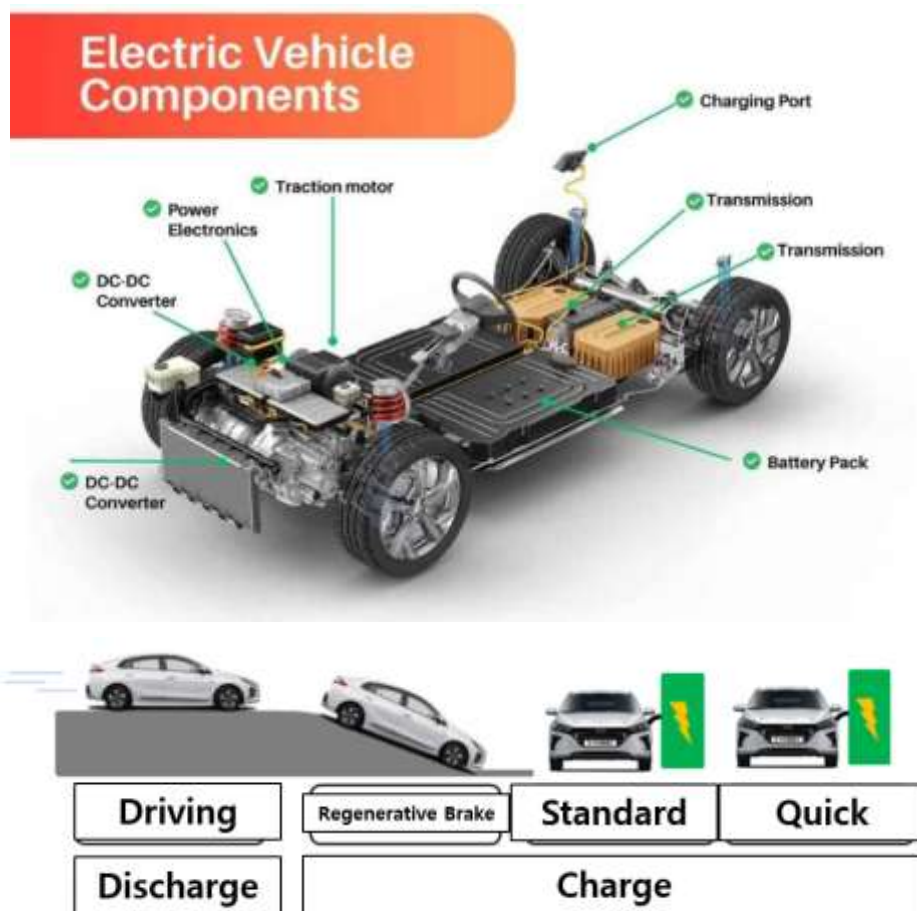
Job Sheet 8

Day	8	Task No.		Time	8h
Title	Battery Electric Vehicle				
Material	Name		Spec	Q'ty	
	Test Lamp		LED	1	
	Circuit Tester		With Beep	1	
	Electrical Troubleshooting Manual		EV6	1	

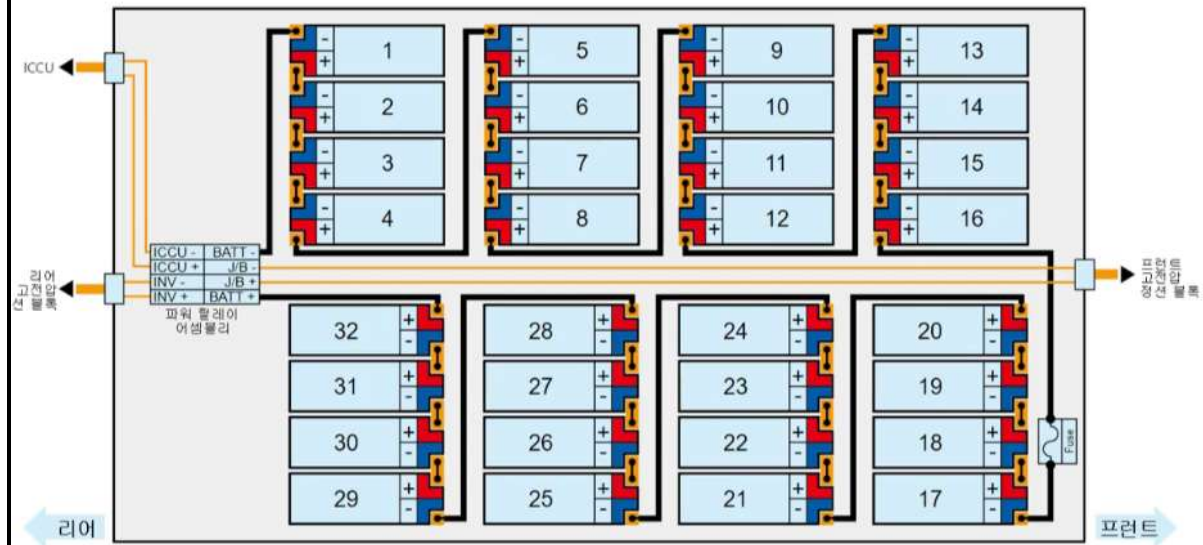
1. Purpose

- After completing this practice, the student should be able to:
 - Inspect and cut off high voltage according to the maintenance manual.
 - Understand the high voltage system and diagnose it by referring to the maintenance manual and circuit diagram.
 - Diagnose high voltage battery components using diagnostic equipment according to the maintenance manual.
 - Inspect power conversion devices and drive devices according to the maintenance manual.

2. Job Figures 1

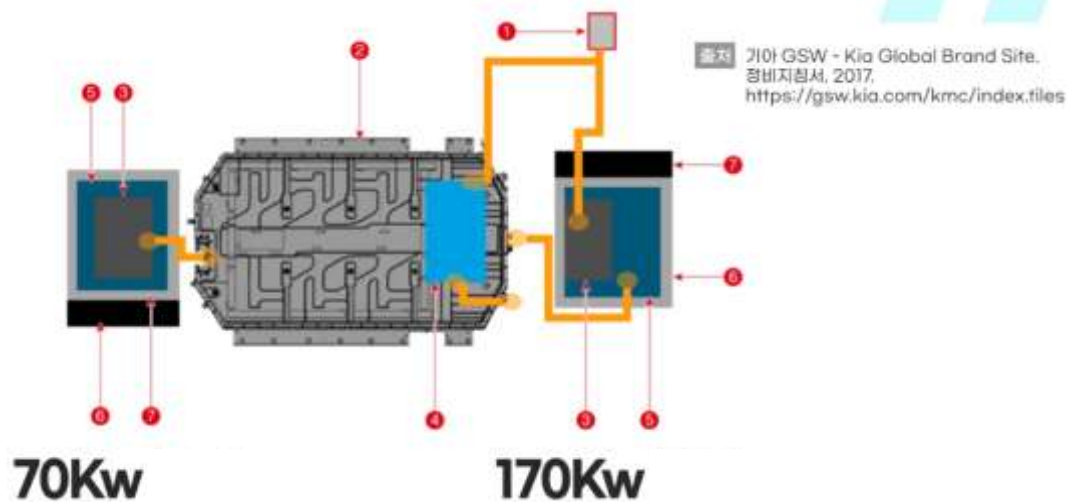


3. Job Figures 2



출처 기아 GSW - Kia Global Brand Site. 정비지침서, 2017.
<https://gsw.kia.com/kmc/index.tiles>

4. Job Figures 3



□ Information: <https://ecogears.in/advantages-and-disadvantages-of-electric-vehicles-in-india/>

□ Requirements: Analysis construction of battery electric vehicle

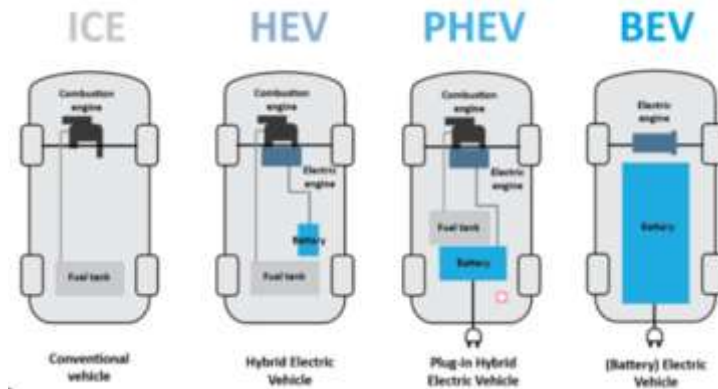
Job Sheet 9

Day	9	Task No.		Time	8h
Title	Hybrid Electric Vehicle				
Material	Name		Specification	Q'ty	
	Test Lamp		LED	1	
	Circuit Tester		With Beep	1	
	Electrical Troubleshooting Manual		EV6	1	

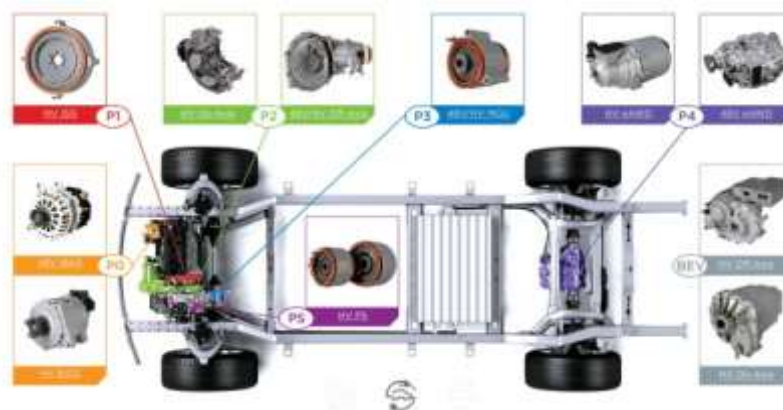
1. Purpose

- After completing this practice, the student should be able to:
 - Safely diagnose and cut off high voltage according to the maintenance manual.
 - Diagnose by understanding the high voltage system and referring to the maintenance manual and circuit diagram.
 - Diagnose high voltage battery components using diagnostic equipment according to the maintenance manual.
 - Diagnose power conversion devices and drive devices according to the maintenance manual.

2. Job Figures(ICE vs Hybrid Vehicle)



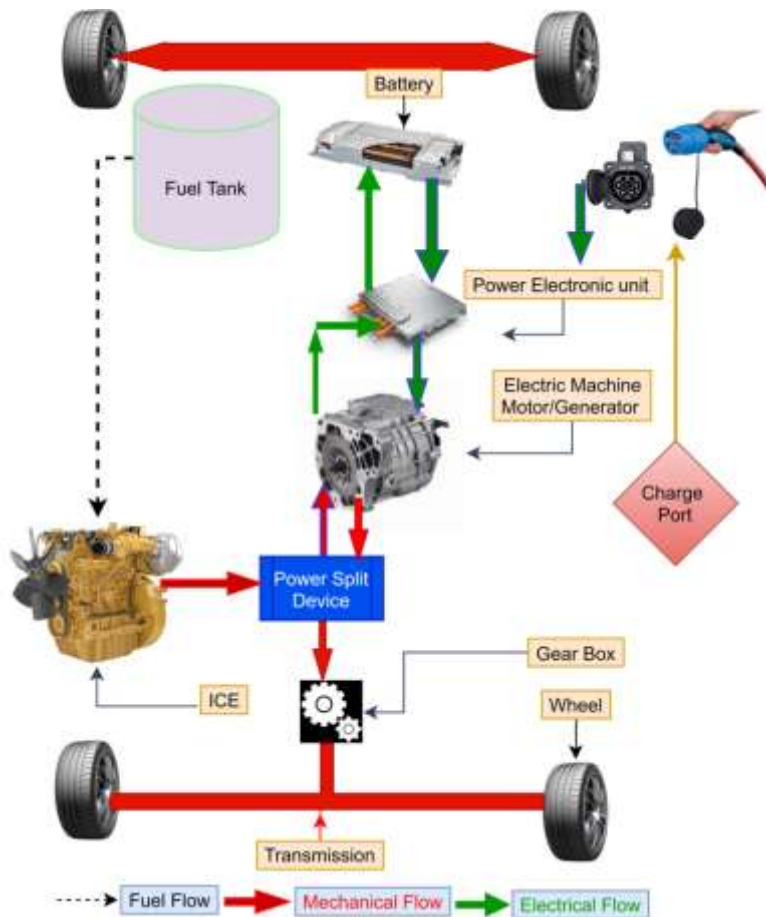
3. Job Figures(Hybrid Vehicle)



4. Job Figures(Motor Generator)



5. Job Figures(Plug-in Hybrid Vehicle)



□ Information: https://www.researchgate.net/figure/Plug-in-Hybrid-Electric-Vehicle-PHEV-block-diagram_fig1_374114275

□ Requirements: Analysis construction of hybrid electric vehicle

Job Sheet 10

Day	10	Task No.		Time	8h
Title	FCEV(Fuel Cell Electric Vehicle)				
Material	Name	Spec	Q'ty		
	Test Lamp	LED	1		
	Circuit Tester	With Beep	1		
	Electrical Troubleshooting Manual	EV6	1		

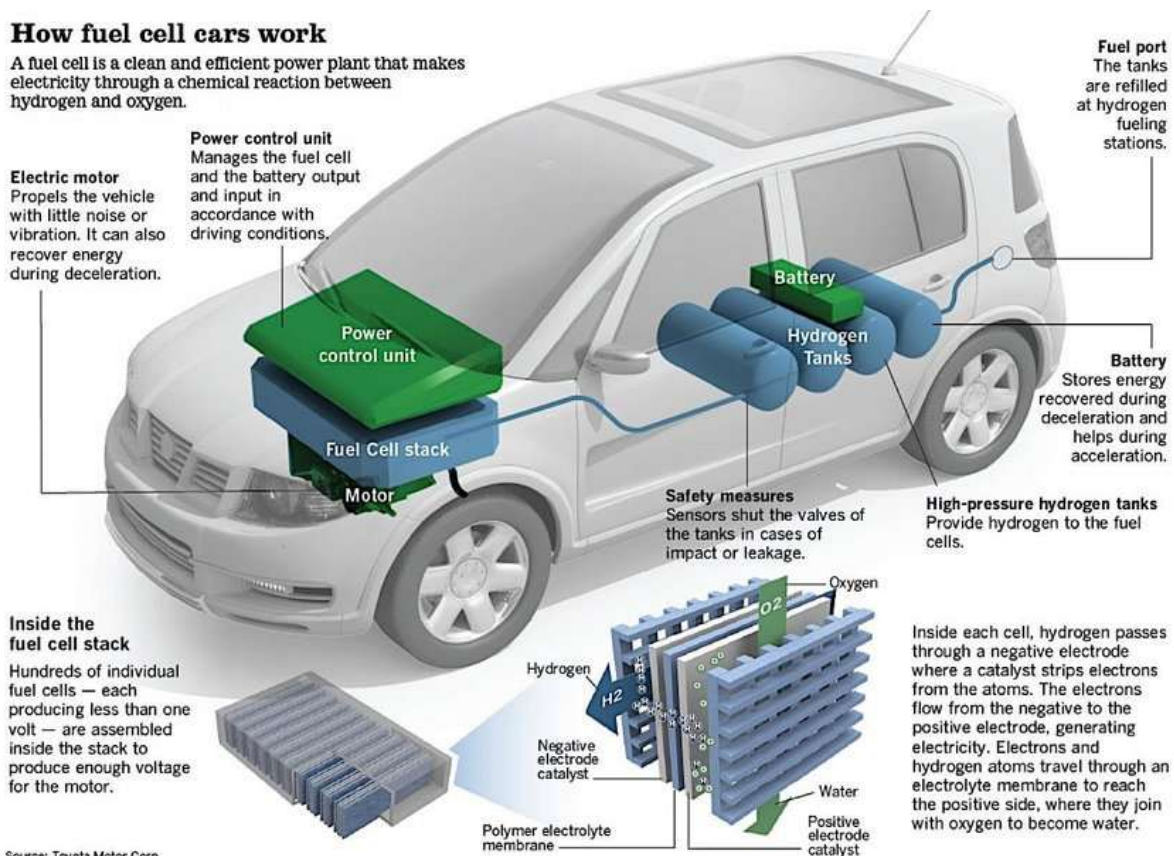
1. Purpose

- After completing this practice, the student should be able to:
 - Understand the operating principles of hydrogen fuel cell vehicles.
 - Explain the components of hydrogen fuel cell vehicles.

2. Job Figures(How fuel cell cars work)

How fuel cell cars work

A fuel cell is a clean and efficient power plant that makes electricity through a chemical reaction between hydrogen and oxygen.



3. Job Figures(How does a hydrogen drive work)



4. Job Figures(FECV System Unit)

High efficient variable pressure control system
- Modularized, downsized, and weight reduced system

✓ Fuel Processing System

Moves hydrogen from the tank and supplies it into stack in recirculation system

✓ Air Processing System

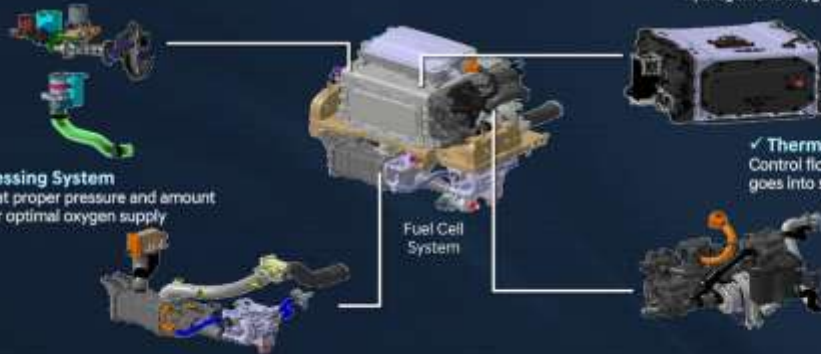
Supplies air at proper pressure and amount into stack for optimal oxygen supply

✓ Fuel Cell Stack

Core device that enables electrochemical reaction of hydrogen and oxygen to produce electric energy

✓ Thermal Management System

Control flow and temperature of coolant that goes into stack for optimal chemical condition



□ Information:

https://www.researchgate.net/figure/Fuel-Cell-Electric-Vehicles-FCEV-Toyota-Source-97_fig10_292138701

<https://www.bmw.com/en/innovation/how-hydrogen-fuel-cell-cars-work.html>

https://www.hydrogenbatteries.org/FCEVs_Fuel_Cell_Electric_Vehicles.htm

<https://www.innovationnewsnetwork.com/electric-vehicles-vs-hydrogen-fuel-cell-vehicles-comparing-the-benefits/45393/>

□ Requirements: Analysis construction of fuel cell electric vehicle