



SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)
COIMBATORE-35

Accredited by NBA-AICTE and Accredited by NAAC – UGC with A+ Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai



UNIT II: HYBRID ELECTRIC DRIVE - TRAINS

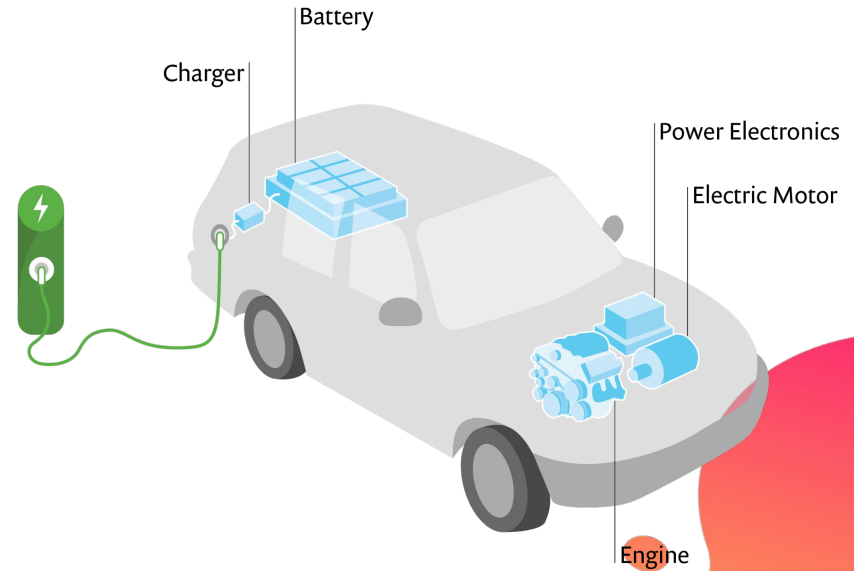
TOPIC: **INTRODUCTION TO VARIOUS HYBRID
DRIVE - TRAIN TOPOLOGIES**





INTRODUCTION

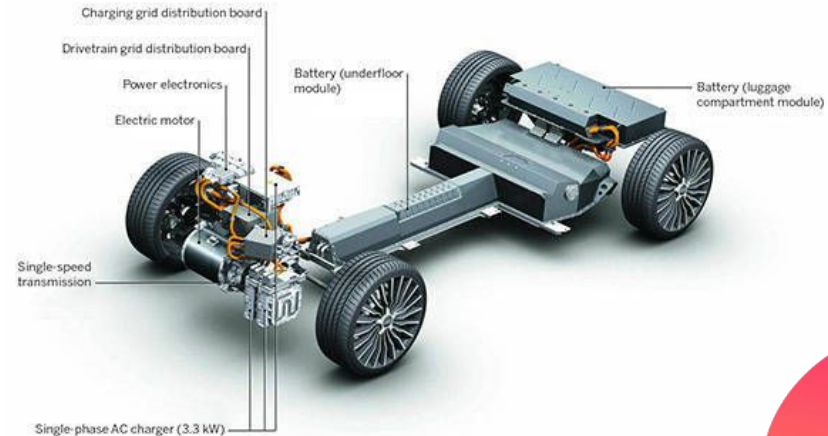
- The term hybrid vehicle refers to a vehicle with at least two sources of power.
- Hybrid-electric vehicle indicates that one source of power is provided by an electric motor.
- There are many types of HEVs, such as:
 - Gasoline ICE and battery, diesel ICE and battery, battery and FC, battery and capacitor, battery and flywheel, Battery and battery hybrids.





TYPES

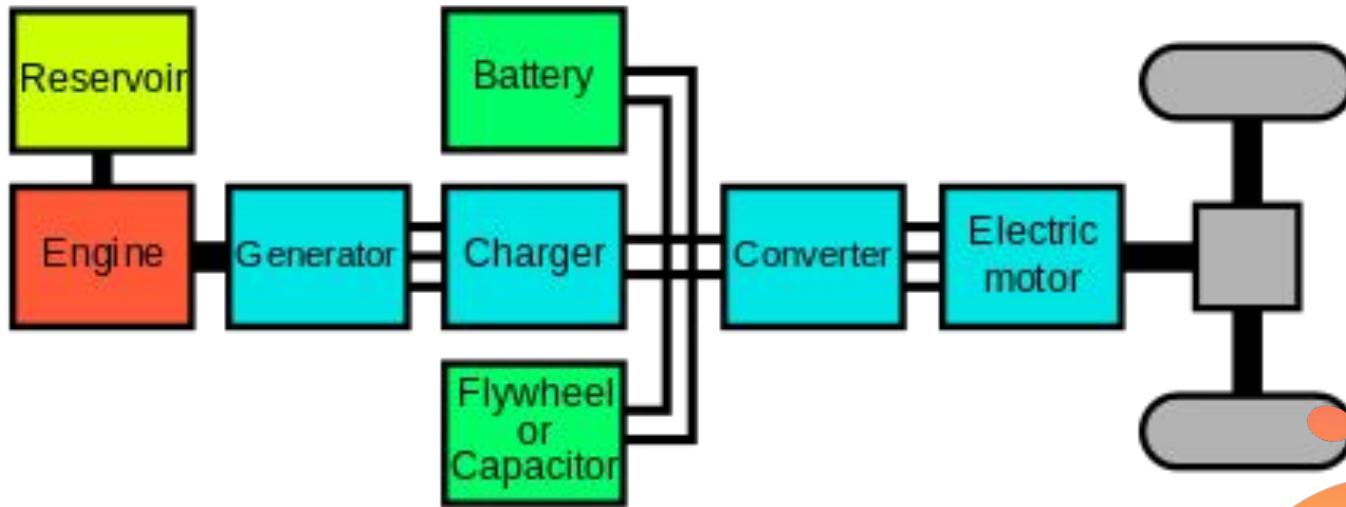
- There are three types of hybrid drive - train topologies.
- They are:
 - Series Hybrid
 - Parallel Hybrid
 - Series - Parallel Hybrid





SERIES HYBRID

- In series hybrid system the mechanical output is first converted into electricity using a generator.
- Conceptually, it is an ICE assisted Electric Vehicle (EV).





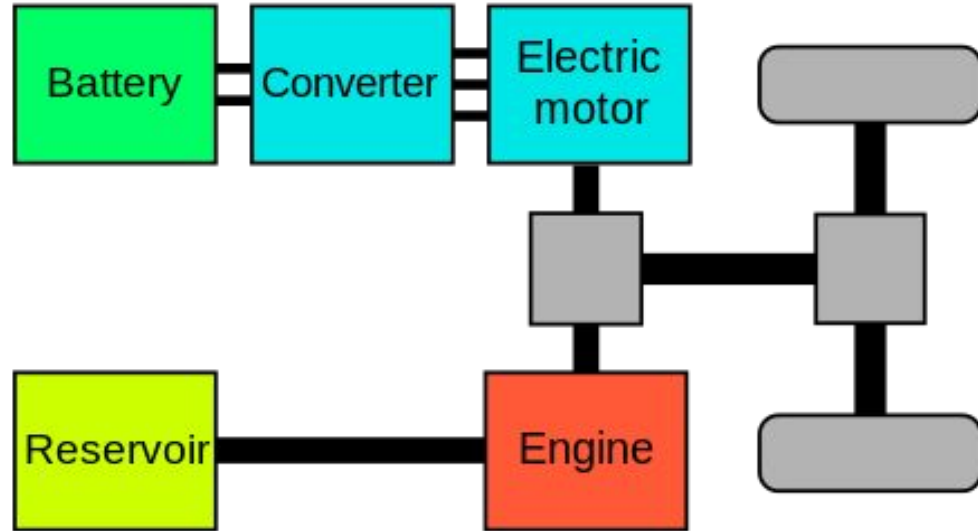
ADVANTAGES & DISADVANTAGES

- The advantages of series hybrid drivetrains are:
 - Mechanical decoupling between the ICE and driven wheels allows the IC engine operating at its very narrow optimal region
 - Nearly ideal torque-speed characteristics of electric motor make multi-gear transmission unnecessary.
- However, a series hybrid drivetrain has the following disadvantages:
 - The energy is converted twice (mechanical to electrical and then to mechanical) and this reduces the overall efficiency.
 - Two electric machines are needed and a big traction motor is required because it is the only torque source of the driven wheels.



PARALLEL HYBRID

- The parallel HEV allows both ICE and electric motor (EM) to deliver power to drive the wheels.
- Since both the ICE and EM are coupled to the drive shaft of the wheels via two clutches, the propulsion power may be supplied by ICE alone, by EM only or by both ICE and EM.





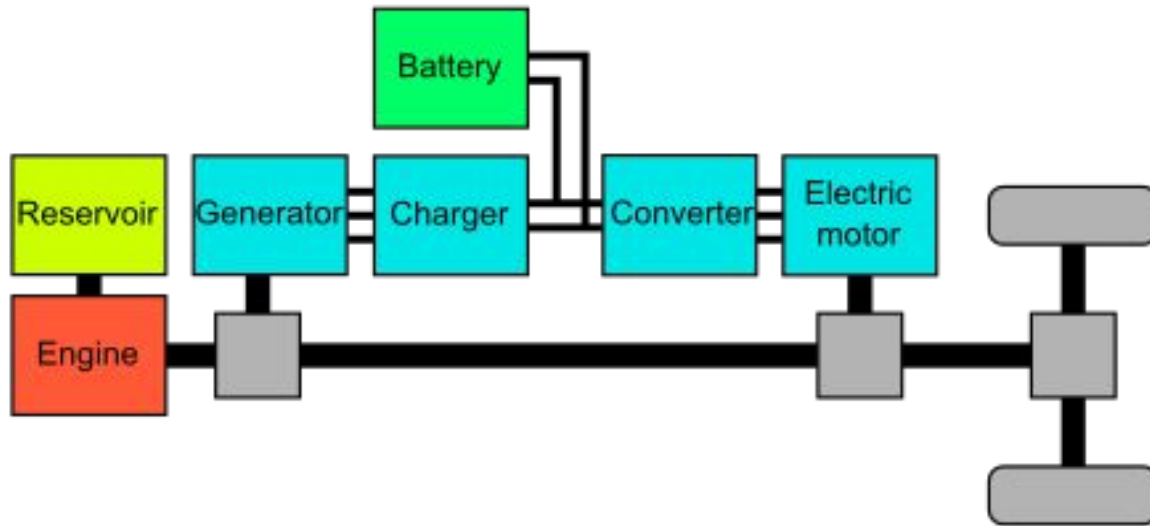
ADVANTAGES & DISADVANTAGES

- The advantages of the parallel hybrid drivetrain are:
 - Both engine and electric motor directly supply torques to the driven wheels and no energy form conversion occurs, hence energy loss is less
 - Compactness due to no need of the generator and smaller traction motor.
- The drawbacks of parallel hybrid drivetrains are:
 - Mechanical coupling between the engines and the driven wheels, thus the engine operating points cannot be fixed in a narrow speed region.
 - The mechanical configuration and the control strategy are complex compared to series hybrid drive train.



SERIES - PARALLEL HYBRID

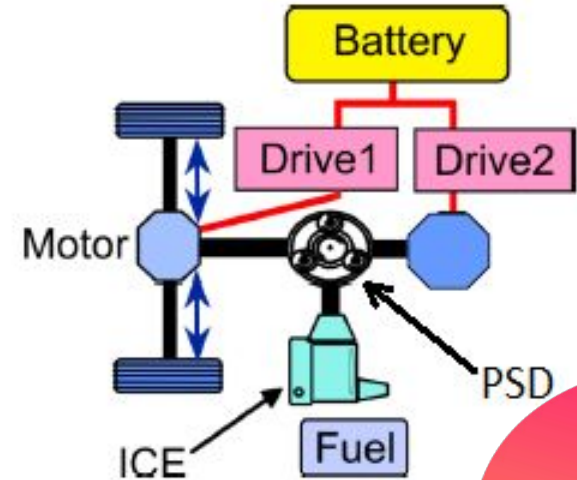
- In the series-parallel hybrid, the configuration incorporates the features of both the series and parallel HEVs.
- However, this configuration needs an additional electric machine and a planetary gear unit making the control complex.





COMPLEX HYBRID SYSTEM

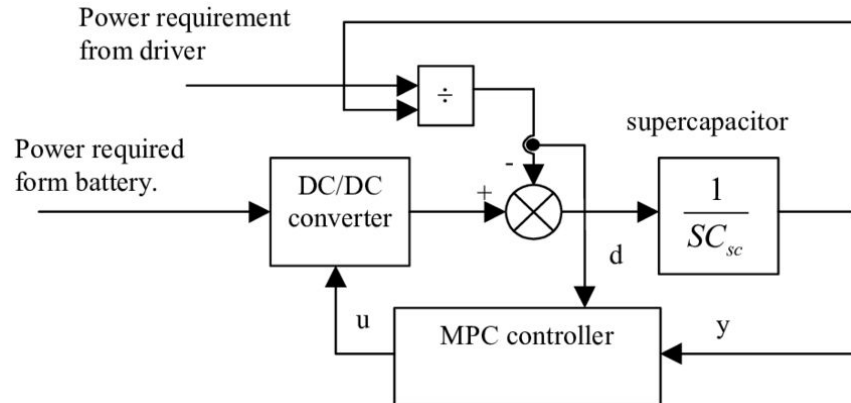
- The complex hybrid system involves a complex configuration which cannot be classified into the above three kinds.
- The complex hybrid is similar to the series-parallel hybrid since the generator and electric motor is both electric machines.
- However, the key difference is due to the bi-directional power flow of the electric motor in complex hybrid and the unidirectional power flow of the generator in the series-parallel hybrid.
- The major disadvantage of complex hybrid is higher complexity.





POWER FLOW CONTROL

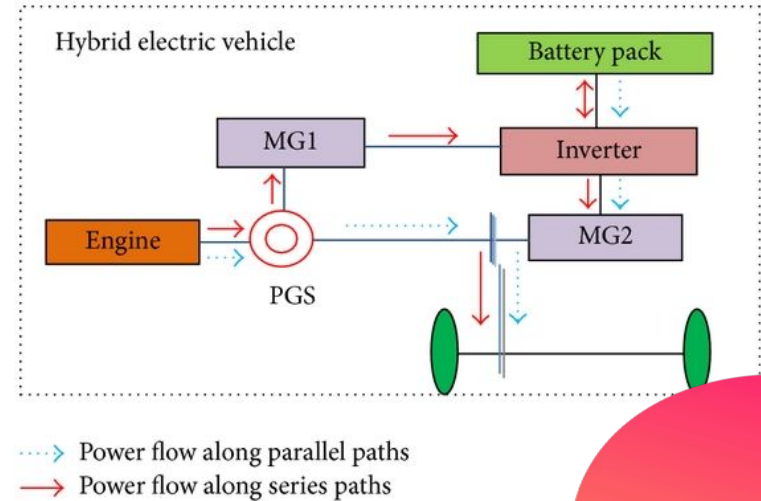
- Due to the variations in HEV configurations, different power control strategies are necessary to regulate the power flow to or from different components.
- All the control strategies aim satisfy the following goals:
 - maximum fuel efficiency
 - minimum system costs
 - minimum emissions
 - good driving performance





POWER FLOW CONTROL

- The design of power control strategies for HEVs involves different considerations such as:
 - **Optimal ICE operating point:** The optimal operating point on the torque- speed plane of the ICE can be based on maximization of fuel economy, the minimization of emissions or a compromise between fuel economy and emissions.
 - **Optimal ICE operating line:** In case the ICE needs to deliver different power demands, the corresponding optimal operating points constitute an optimal operating line.





THANK YOU