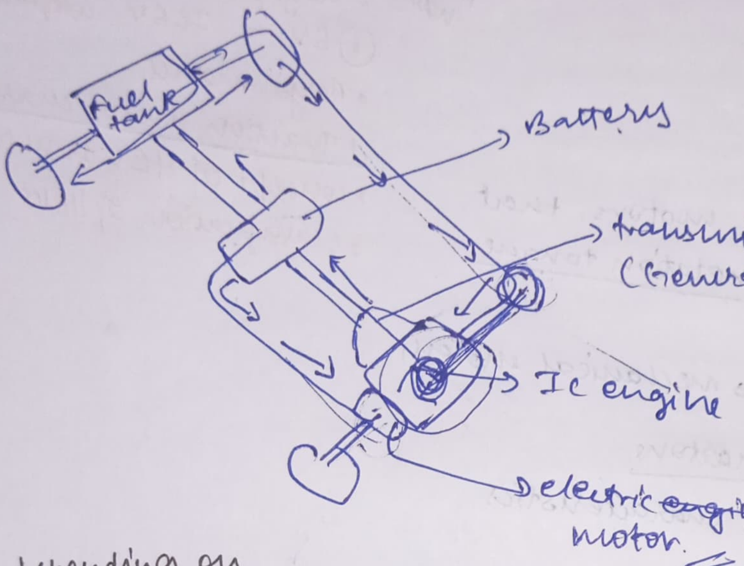
Parallel Hybrid ~~veh~~ Vehicle

~~[illegible]~~ → Hybrid Electric Drive Train

↳ 2 sources of power
- electric motor
- IC engine.

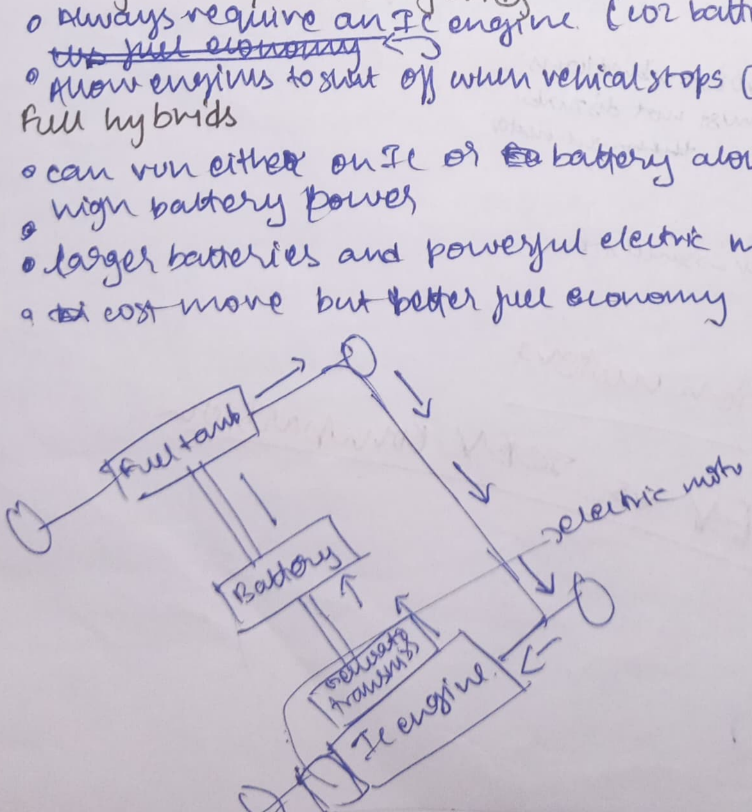
Internal combustion in EVs



→ Pg 79

depending on
Structure of drive train
- → series hybrid / Micro hybrid
- → ‖ hydrid
- → series – ‖ hydrid or power split hybrid.

Degree of hybridization
- → Mild hybrids / Micro hybrids
  - Always require an IC engine. (coz battery small capacity)
  - ~~the fuel economy~~
  - Allow engines to shut off when vehical stops (traffic) ∴ useful economy
- → Full hybrids
  - can run either on IC or ~~[illegible]~~ battery alone coz high battery power
  - larger batteries and powerful electric motors
  - ~~[illegible]~~ cost more but better fuel economy



Regenerative Braking

↳ recovery of KE during braking

→ use an electric motor → recovers a portion of KE

- extended range (mileage)
- Lower fuel consumption
- improves emmission control } adv

Principle

↳ when brake pedal
↓
Electric motor switches to generator mode
↓
KE —drive train→ generator
↓ converts braking torque (KE
both deceleration and energy generation ⟸ electric energy

⟹ the no. of n

=

This is cancelled.

Hello

Capita $\frac{c}{2}$ = cancelled

- At low speeds the generator can no longer supply braking torque, as the friction brake is activated.

" Motor controller " → switching to generator mode

Torque Blending } ⟹ This is a process where the braking torque is continuously adopted by the friction braking system to the current generative braking torque.?

Adv of ~~Regenerative Braking~~ electric cars	disadv
Environmentally friendly	Less power
Economical	expensive to purchase
light build / regenerative braking	Poorer handling
High resale value	high maintainance cost
	High voltage batteries

Challenges

→ req → energy storage devices with high power-to-energy ratios

→ Frequent shut down and restart of EVs should be optimized

→ Reduce size, weight, and cost

→ Advanced cooling for propulsion system ~~component~~ components

→ higher fuel → power conversion efficiency

components of a hybrid vehical

1) inverter → energy is stored as DC in battery
→ converts DC → AC (for the motor to run)
→ hybrid vehical runs on AC power

2) DC/DC converter

high V, DC (traction battery pack) → low V DC
- to run vehical auxiliaries
- to recharge auxiliary battery

3) Electric generator

external power source → energy → generator → electricity → charges battery

in series hybrids
↓
IC engine

4) control Module
→ synchronizes all the power soured employed
→ most important

series hybrid vehical

difference

Series	Parallel
• pure electric propulsion mechanical → electrical → power ↓ either charge battery ↓ or bypass battery to propel the motor.	• Both electric and mechanical propulsion • Both are coupled to the drive shaft via 2 clutches power → IC alone → EM alone → Both IC and EM
• require large capacity batteries	• EM used as generator i) to charge battery in regenerative braking ii) to absorb power from IC when more than required.
• good for low speed, with frequent start-stop	• Note → IC be main character • smaller battery capacity
• like a battery electric vehicle in design	

- generator charges ~~both~~ battery and powers the electric motor
- when large amount of current req ⇒ motor draws from
  - ↙ generator
  - → battery

AKA
⇒ Extended Range Electric vehicles.

Adv	disadv
~~No transmission~~ • No clutch • Mechanical decoupling between IC and wheels allows IC engine operational optimal • no multi-gear transmission required	• Energy is converted twice Mech → elec → Mech reduces overall efficiency • completely dependent on battery power • not compact coz of motor + generator.

Application — heavy commercial vehicles
— military vehicles etc.

Reason — large vehicles have space for the bulky engine/generator

coz EM only ~~powers~~ supports IC
(boost is required)
- more effective in high speed driving
- no separate generator
  ⇒ motor functions as a generator.

Adv	disadv
• no energy form conversion is required • compact and light weight coz both energy sources work simultaneously	• Mech coupling ~~[illegible]~~ at narrow speed regions (engine operation points cannot be fixed) • control ~~stat~~ strategy complex wrt series ⇓ complex software and hardware

⇒ small vehicles use ‖ configuration.
⇒ most passenger cars.

Series – ‖ ~~power split~~ Hybrid vehicle

or power split hybrid.

- depending on the load either
  - → series
  - → ‖
  } governed by control module

IC engine
- → charge battery
- → drive wheels

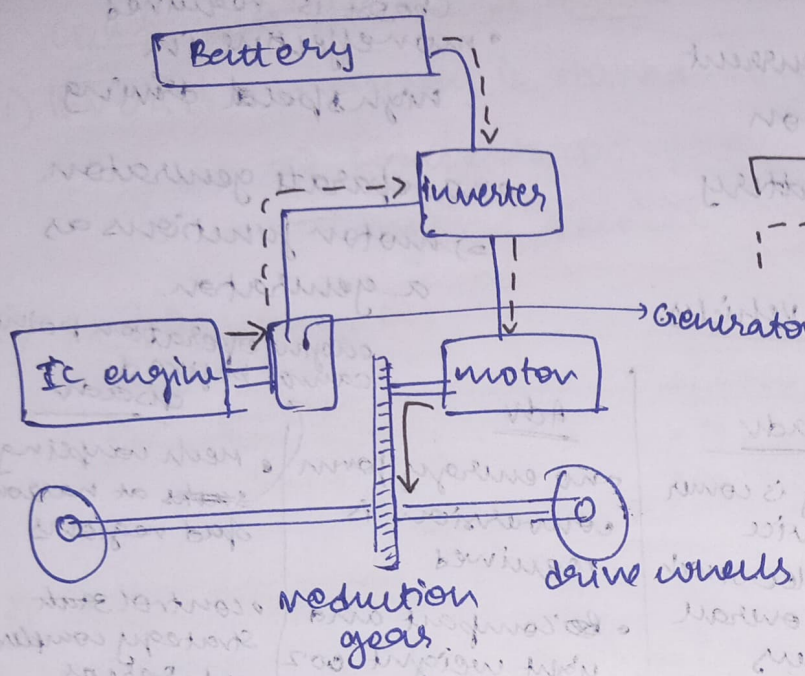
} ⇒ high efficiency & performance

But requires additional
1) planetary gear unit
2) electric machine

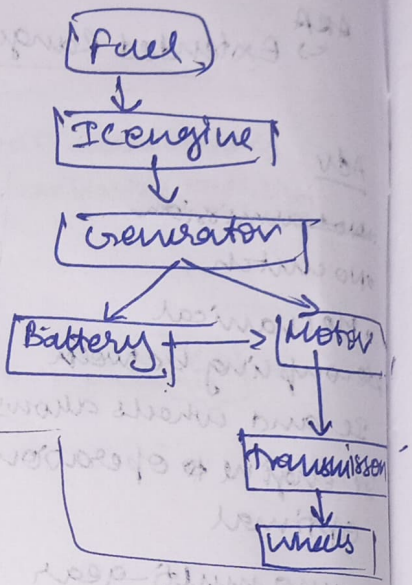
} complex.

Note → pg 65 diagrams
→ advantages of hybrid electric stuff

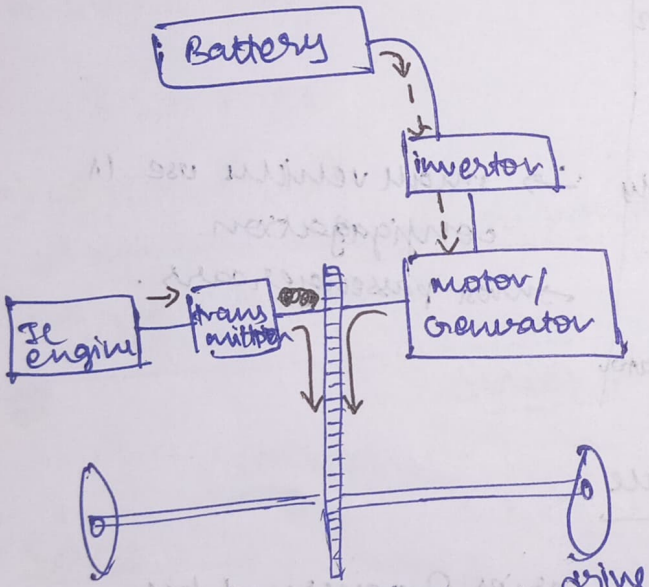
Series

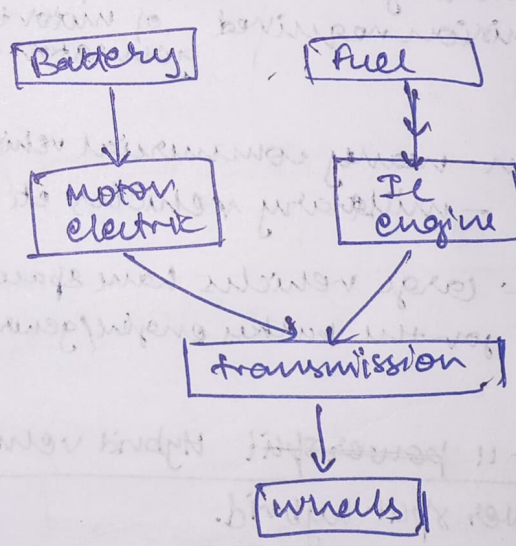


mech power
electrical power



Parallel



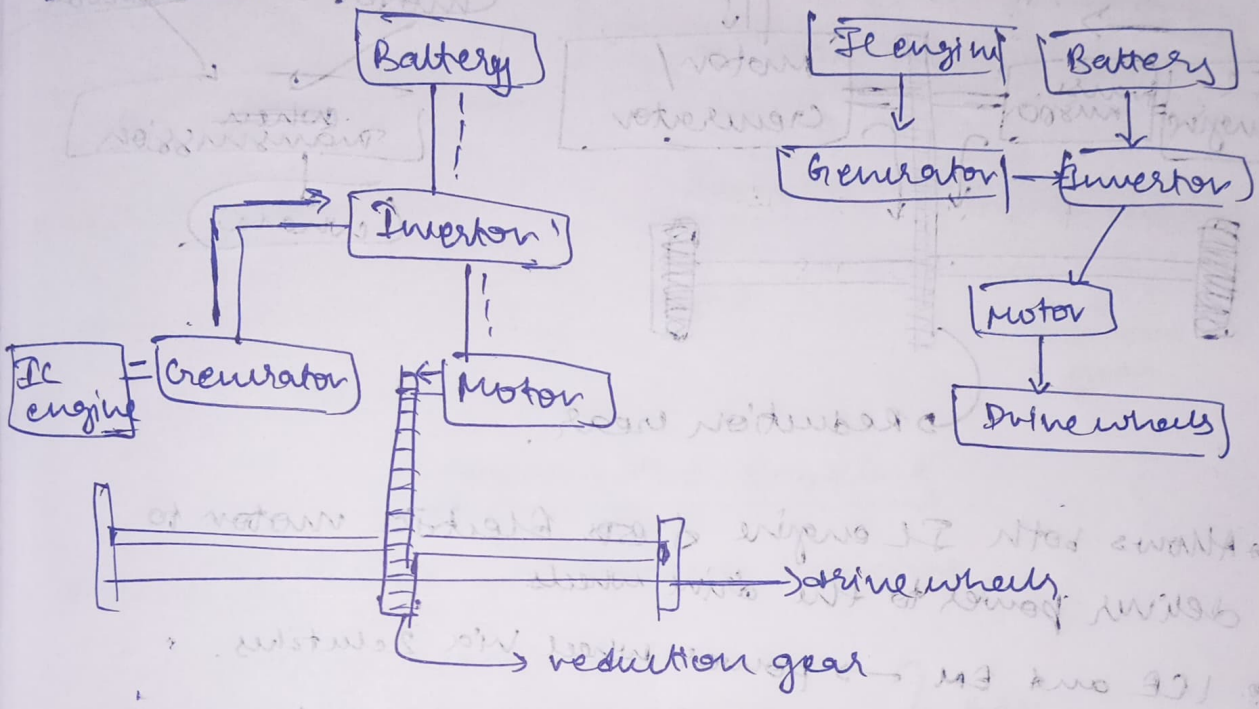


Javascript

HEV

1) series 2) Parallel 3) Series-Parallel type
4) Regenerative Braking.

1) series



- IC engine is coupled with the generator to produce electricity for pure electric propulsion
- Mech → electric → mech ⟹ low energy efficiency
- converted electricity → either charges battery
  → propel wheels via motor
- Used → heavy commercial vehicles
  → military vehicles.
- Space for generator and motor.
- efficient for → low speed driving / frequent start-stop

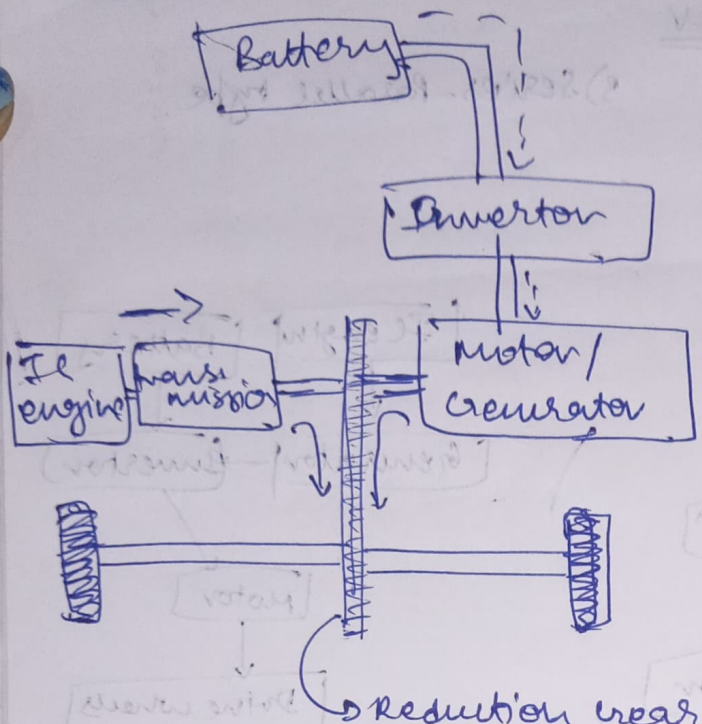
Adv

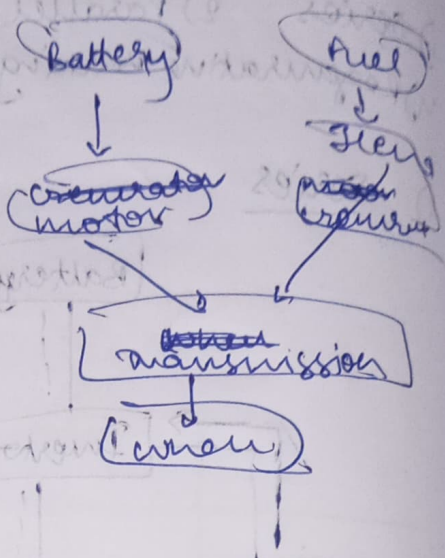
- No transmission
- No torque converter

Disad

- low energy efficiency
- complete dependency of battery power

Parallel





- Allows both IC engine & Electric motor to deliver power to the drive wheels.
- ICE and EM → power wheel via 2 clutches.
- EM → acts as generator to charge the battery using regenerative braking.

Adv

- no energy conversion.
- less weight coz of lack of separate generator

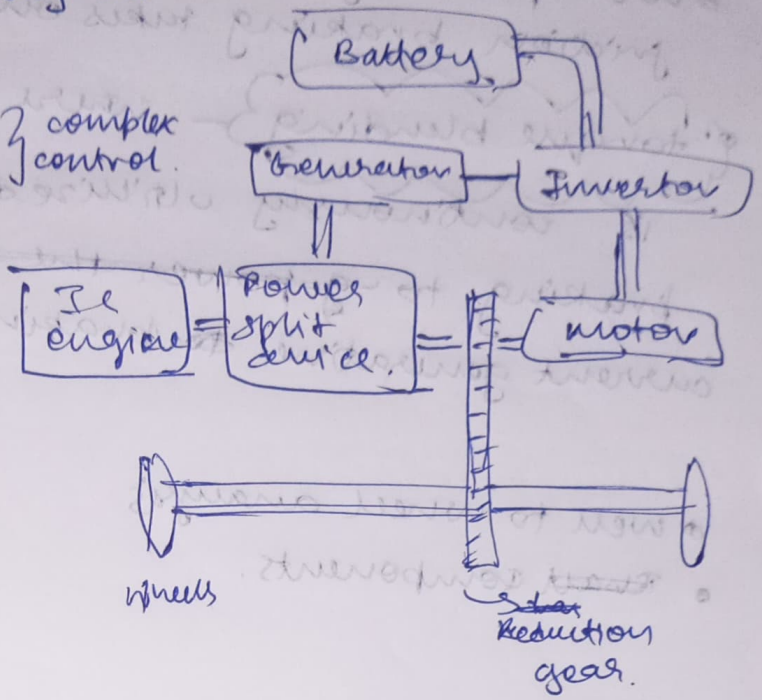
Dis

- engine operating points cannot be fixed in narrow speed region
- seamless blending of energies makes the control unit more complex.

used → passenger type cars.

series Parallel

- IC engine charges battery and drives the wheel
- + electric machine + planetary gear unit } complex control.
- combination
- depending on the load of the vehicle
- control module governs the selection of the suitable mode.



Regenerative Braking

- recovery of KE lost during braking.
  - ↳ extended range
  - ↳ lower fuel consumption
  - ↳ improves emission control. } Adv.

Principal

- brake pedal applied
  - ↓
  - Electric motor converts to generator mode.
- Aim → deceleration and energy retention
- KE —(drive train)→ generator
  - ↓ converts braking torque
  - Electric energy

traction motors

→ used to make rotation torque → type of electric motor
electrical energy → mechanical energy.

quick reversal into generator to aid in regenerative braking

Characteristics

Mechanical

1) Light weight
- low power : weight ratio

2) Totally enclosed
- protects itself dirt, water and anti-corrosion

3) Robust
→ strong to withstand comm vibrations.

liter

Electrical

1) ~~High starting torque~~
→ start off with heavy load and acc to max speed

2) Parallel running
→ easy mechanical coupling to load share almost constant

3) ~~Easy~~ Speed control
→ economical and linear speed control.

4) Regenerative or Dynamic ~~brake~~ braking
- simple method of R/D braking

5) High efficiency
- mech ↔ elec. efficiency should be high.

- low speeds generator is not activated, friction braking takes over.
- torque blending — where the braking torque is continously utilized by the friction braking to ~~power the generator~~ the current generative ~~to~~ braking torque //

- well to wheel analysis
- ~~Exact~~ components.