UNIT- III

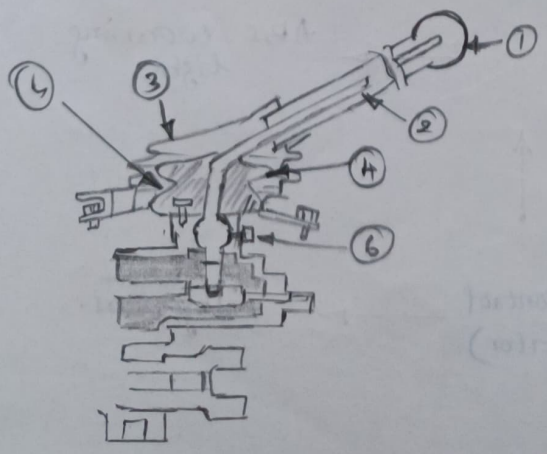
DRIVE LINE CONTROL SYSTEM

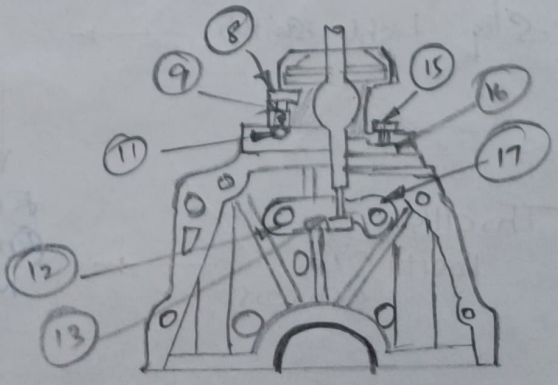
GEAR SHIFTING CONTROL: (Gear shifting control. pdf).

Gear shifting control system, by its mechanical structure, the movement of the gear shift lever, which is located beside the driver's seat, directly actuates the gear shift fork shaft to shift the gear into the selected position.

The main parts are:

* Gear shift lever knob (1)
* Gear shift lever (2)
* Gear shift lever boot (3)
* Gear shift lever case cover (4)
* Gear shift lever locating bolt (5)
* Gear shift lever case.
* Low speed select pin bolt (15)
* Low speed select guide pin (16)
* Low speed gear shift fork shaft (17)
* Reverse select pin screw (8)
* Reverse select locating springs (9)
* Reverse select locating ball
* Reverse select guide pin (11)
* Reverse gear shift fork shaft (12)
* Select return springs
* Gear shift lever wave washer
* Gear shift lever seat.



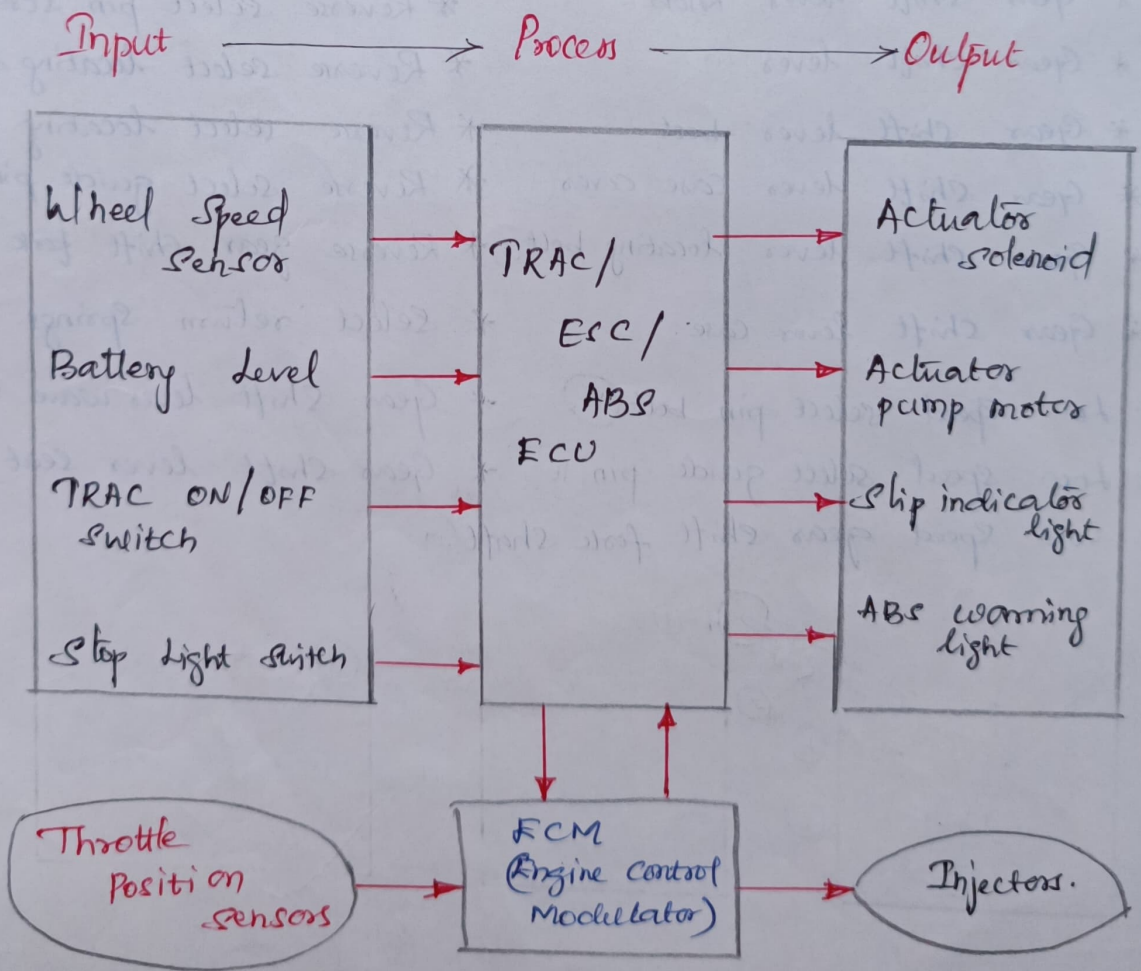


Traction Control System (TCS) / Braking.

* Traction is the maximum frictional force that can be produced between surface without slipping.

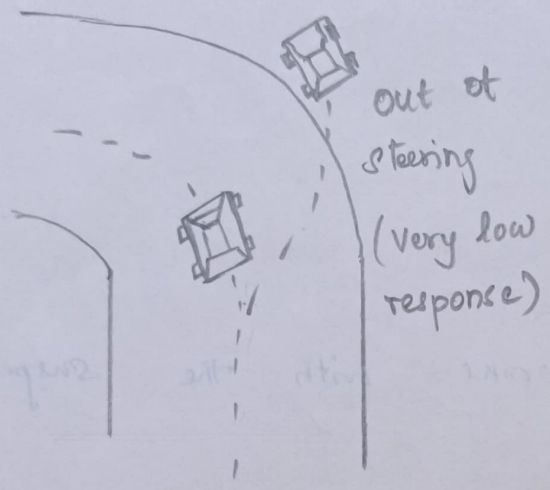
* Traction Control (TRAC) helps drivers to avoid crashes by reducing the danger of skidding or losing control.

Block diagram:



* The TRAC includes both mechanical and electronic components & systems.

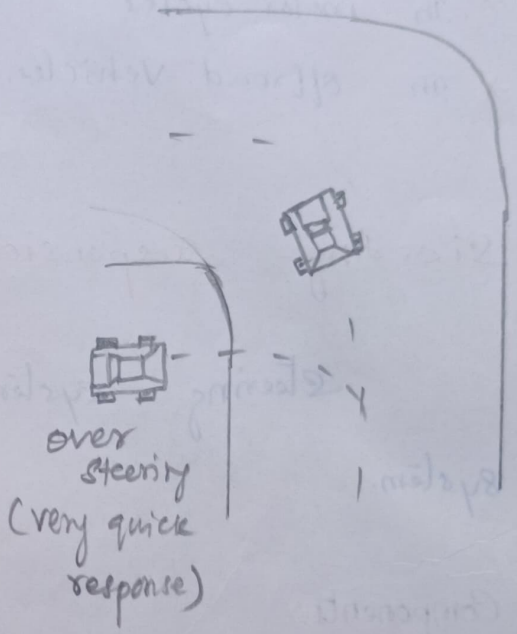
Understeer



⇒ Front wheels skid

⇒ Vehicle plows straight

Oversteer



⇒ Rear wheels skid

⇒ Vehicle spins around.

Advantages of Traction control.

- Avoiding accidents
- Sudden twists and turns
- slippage of the wheels
- stopping distances
- Driving a powerful car.
- Most gripping.

Disadvantages of Traction Control

✗ Wear on brake components

✗ Allows 10% wheel slip

✗ Its banned in F1 Racing.

Applications of Traction control system:

* Safety
* In road cars
* In race cars
* In motor cycles
* In offroad vehicles.

Steering - Suspension:

Steering system works with the suspension system.

Components:

* steering gear
* steering linkage
* steering wheel
* steering column.

Types of steering:

* Rack & pinion
* Re-circulating ball bearing.
* Worm & worm wheel.
* Hydraulic steering
* Electronic power steering

Steering Ratio

- Amount of steering wheel rotation.
- Steering wheel turned all the way in one direction to stop against a lock.

Turning radius:

- Amount of space required for a vehicle to turn around.

Recirculating Ball and nut steering Gear:

- Sector gear meshes with ball nut.
  * Ball nut rides on bearings on the worm shaft.
- Provides the smooth steering feel.
- Ball nut has curved channels.
- steering shaft has bearing channels.
  * Balls rotate & re-circulate through tubes.

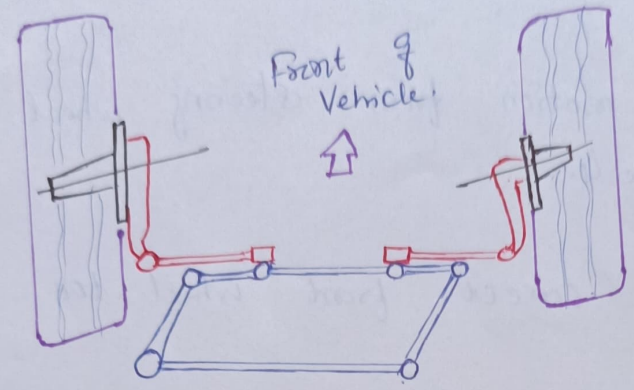
Rack and Pinion Steering:

- End of steering shaft has a pinion gear.
  * meshes with the rack gear.
- Lighter & easier to install than standard steering gear.
- Often has a faster ratio.
- More easily damaged when front wheels hit a curb or rock.
- Transmit more road shock.

Steering Linkage:

- Steering gear is connected to wheels by steering linkage.
- Parts vary depending on design.
  * Tie-rods
  * Steering arms.
  * Steering knuckle.
- Parallelogram steering design.
  * Most popular.
  * Used with long & short arm suspension.

Parallelogram steering linkage:



- Recirculating ball gear uses parallelogram steering.
  * Name comes from parallelogram shape made by steering linkage during a turn.
- Characteristics
  * Tie-rods on each side connected by center link
  * Pitman arm connects steering gear box to center link
  * Idler arm supports center link on passager side.

Ball sockets:

- Ball sockets connect steering linkage parts.
  * Allow parts to rotate during a turn.
  * Pivot as the steering deflects during a bump

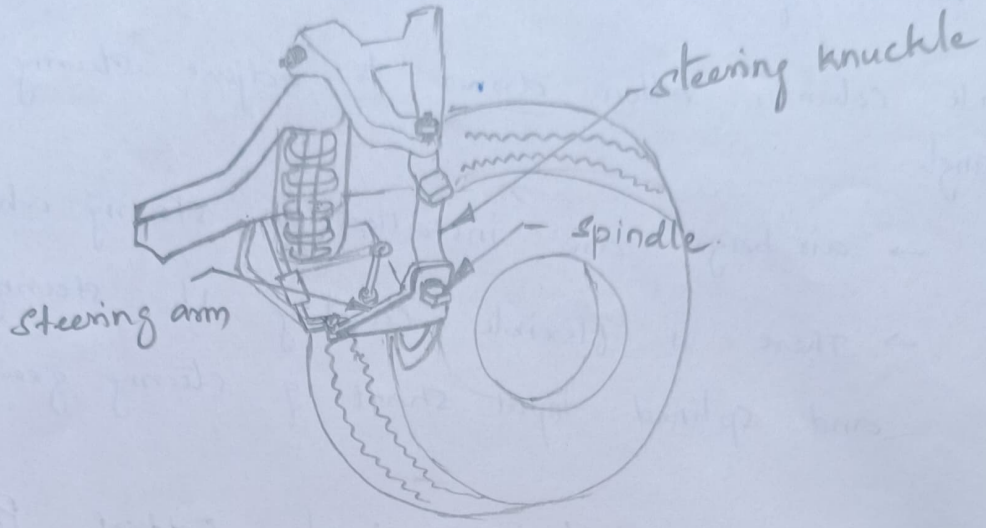
Tie Rods:

- Tie-rod ends attached to pivot points at front wheels.
    * Transmit motion from steering wheel to front wheels.
    * Maintain correct front wheel toe.
- Threaded adjusting sleeve connects inner and outer tie-rods.
    * Right hand thread on one end & left hand thread on other.

Steering Arm:

- Tie-rods attach to front wheels at steering arms
    * Steering arm is attached to steering knuckle
        - Includes spindle.
- During a turn
    * Inside wheel must turn sharper than outside wheel.
- Steering arms angled inward
    * Ackerman angle
    * Toe-out-on-turns.

Steering Suspension Diagram:



Rack and Pinion steering linkage:-

It is less complicated.

- Two tie-rods come out of steering rack.
- Conventional tie-rod end ball sockets on outer ends.
- Inner tie-rod ends are ball sockets enclosed in rubber bellows or boots.

Steering damper:

- minimizes effect of road shocks to steering wheel.

Steering Column:

Steering wheel splined to steering shaft located in center of steering column.

→ Locknut retains steering wheel to shaft.

* Shaft supported by bearings at top & bottom of column.

- Tilt columns allow driver to adjust steering wheel angle.

→ air bags are installed on steering wheel.

→ There is flexible coupling b/w steering shaft and splined input shaft of steering gear.

Electronically controlled Variable Effort Power Steering

- Reasonable Speed: fixed power assist not necessary.

* Late-model vehicles: vehicle speed determines amount of power assist.

* Pump controlled units: actuates solenoid changes fluid flow.

* Steering gear-controlled steering assist: boost is sensed by module.

* Four-wheel steering system: improves handling.

Vehicle Handling:

* Automobile handling and vehicle handling are descriptions of the way a wheeled vehicle responds and reacts to the inputs of a driver, as well as how it moves along a trace or road.

* It is commonly judged by how a vehicle performs particularly during cornering, acceleration and braking as well as on the vehicle's directional stability when moving in steady state condition.

Factors that affect a car's handling:

* Weight distribution
  + Center of mass height
  + Center of mass
  + Roll angular inertia
  + Yaw and pitch angular inertia
* Suspension
* Spring rate
  + Suspension travel

* Tyres and wheels
* Track and wheel base
* Unsprung weight
* Aerodynamics
* Delivery of power to the wheels and brakes
* Steering
* Electronic Stability control [ESC]
* Static alignment of the wheels
* Rigidity of the frame

Ride Characteristics of Road Vehicles:

- Ride quality refers to the degree of protection offered vehicle occupants from uneven elements in road surfaces, or terrain if driving off-road.
- A car with very good ride quality is also a comfortable car to ride in.
- Cars which disturb vehicle occupants with major or minor road irregularities would be judged to have low ride quality.
- key factors for ride quality are vibrations & noise.

* The ride and handling characteristics of an automobile center on the characteristics of the tires.

* Tires are the vehicle's reaction point with the roadway.

* They manage the input forces and disturbances from the road, and they are the final link in driver's chain of output commands.

* Tires characteristics are therefore a key factor in the effect the road has on the vehicle, and in the effectiveness of the output forces that control vehicle stability and cornering characteristics.

* The tire's basic characteristics are managed by the system of springs, dampers and linkages that control the way in which tires move and react to disturbances and control inputs.

Ride characteristics may also depends upon the following:

* Ride comfort
* Implications of high payload - to - vehicle weight ratio
* Ratio of sprung to unsprung weight
* Cornering Dynamics
* Over steer and Under steer.
* Effect of polar moment of Inertia

* Rollover Threshold
* Steering axis inclination
  - Caster
  - Camber
* Steering Geometry
* Front Suspension System
* Rear Suspension System

Adaptive Cruise Control (ACC)

- Adaptive cruise control is an intelligent form of Cruise control (speed control) that slows down and speeds up automatically to keep pace with the car in front of the vehicle.

* A radar system attached to the front of the vehicle is used to detect whether slower moving vehicles are in the ACC vehicle's path.

Working of ACC:

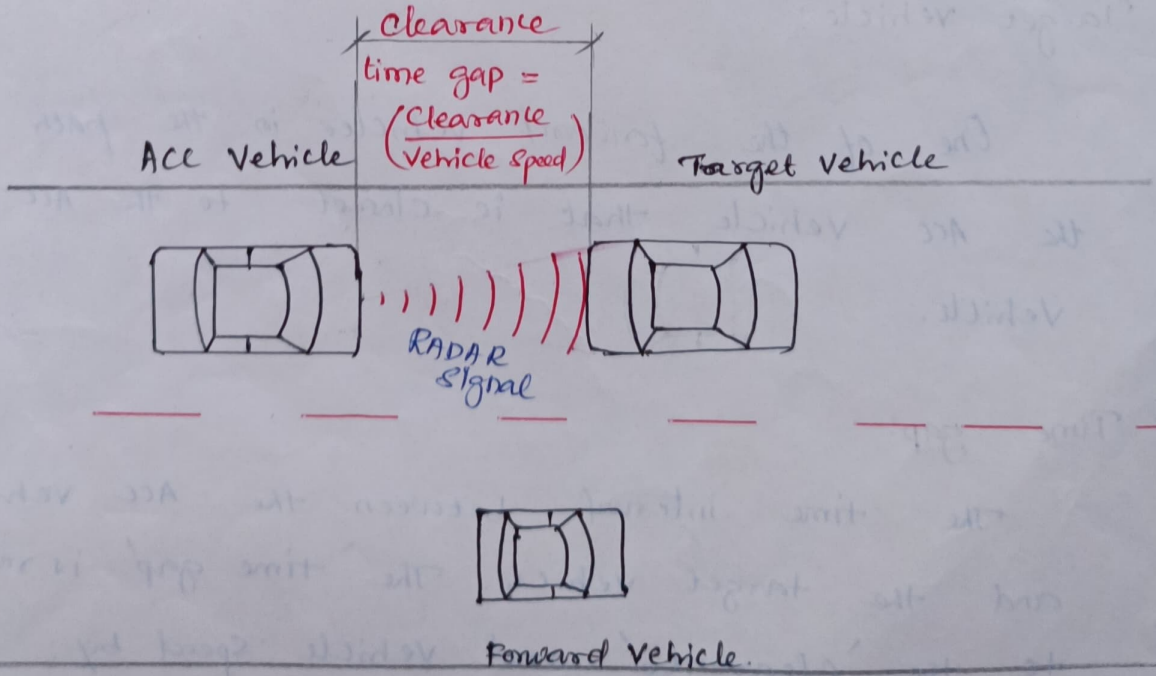
* If a slower moving vehicle is detected, the ACC system will slow the vehicle down

and control the clearance, or time gap, between the ACC vehicle and the forward vehicle.

* If the system detects that the forward vehicle is no longer in the ACC vehicle's path, the ACC system will accelerate the vehicle back to its set cruise control speed.

* This operation allows the ACC vehicle to autonomously slow down and speed up with traffic without intervention from the driver.

* The method by which the ACC vehicle's speed is controlled is via engine throttle control and limited brake operation.



Terminologies:

* Active Brake Control

A function which causes application of the brakes without drives application of brake pedal.

* Clearance:

Distance from the forward vehicle's trailing surface to the ACC vehicle's leading surface.

* Set Speed:

The desired cruise control travel speed set by the drives and is the maximum desired speed of the vehicle while under ACC control.

* Target vehicle:

One of the forward vehicles in the path of the ACC vehicle that is closest to the ACC vehicle.

* Time gap:

The time interval between the ACC vehicle and the target vehicle. The 'time gap' is related to the 'clearance' and vehicle speed by:

time gap = (clearance / ACC vehicle speed)

Components of an ACC system :-

* ACC module:

The primary function of the ACC module is to process the road information and determine if a forward vehicle is present.

* Engine Control Module:

The primary function of the engine control module (ECM) is to receive information from the ACC module and instrument cluster and control the vehicle's speed based on this information.

* Brake Control Module:

The primary function of BCM is to determine vehicle speed via each wheel and to decelerate the vehicle by applying the brakes when requested by the ACC module.

* Instrument Cluster:

The primary function of the instrument cluster is to process the cruise switches and send their information to the ACC and ECMs.

* CAN:

The Controller Area Network (CAN) is an automotive standard that utilizes a 2 wire bus

to transmit and receive data. Each node on the network has the capability to transmit 0 to 8 bytes of data in a message frame.

* Cruise switches:

The cruise switches are mounted on the steering wheel and have several buttons which allow the driver to command operation of the ACC system. The switches include

On: place system in the 'Acc stand by' state

Off: Cancel ACC operation & place system in the 'Acc off' state

Set$^+$: Activate ACC & establish set speed to accelerate.

Set$^-$: Decelerate

Res: Resume to set speed.

Coast: To decelerate or cancel the ACC system.

* Brake switches:

There are two brake switches. When either brake switch is activated, cruise control operation is deactivated and the system enters 'Acc standby' state.

* Brake lights:

When the BCM applies the brakes in response to an ACC request, it will illuminate the brake lights to warn vehicles behind the ACC vehicle that is decelerating.

* Sensors / Radars

Currently 4 types of radars are available. They are

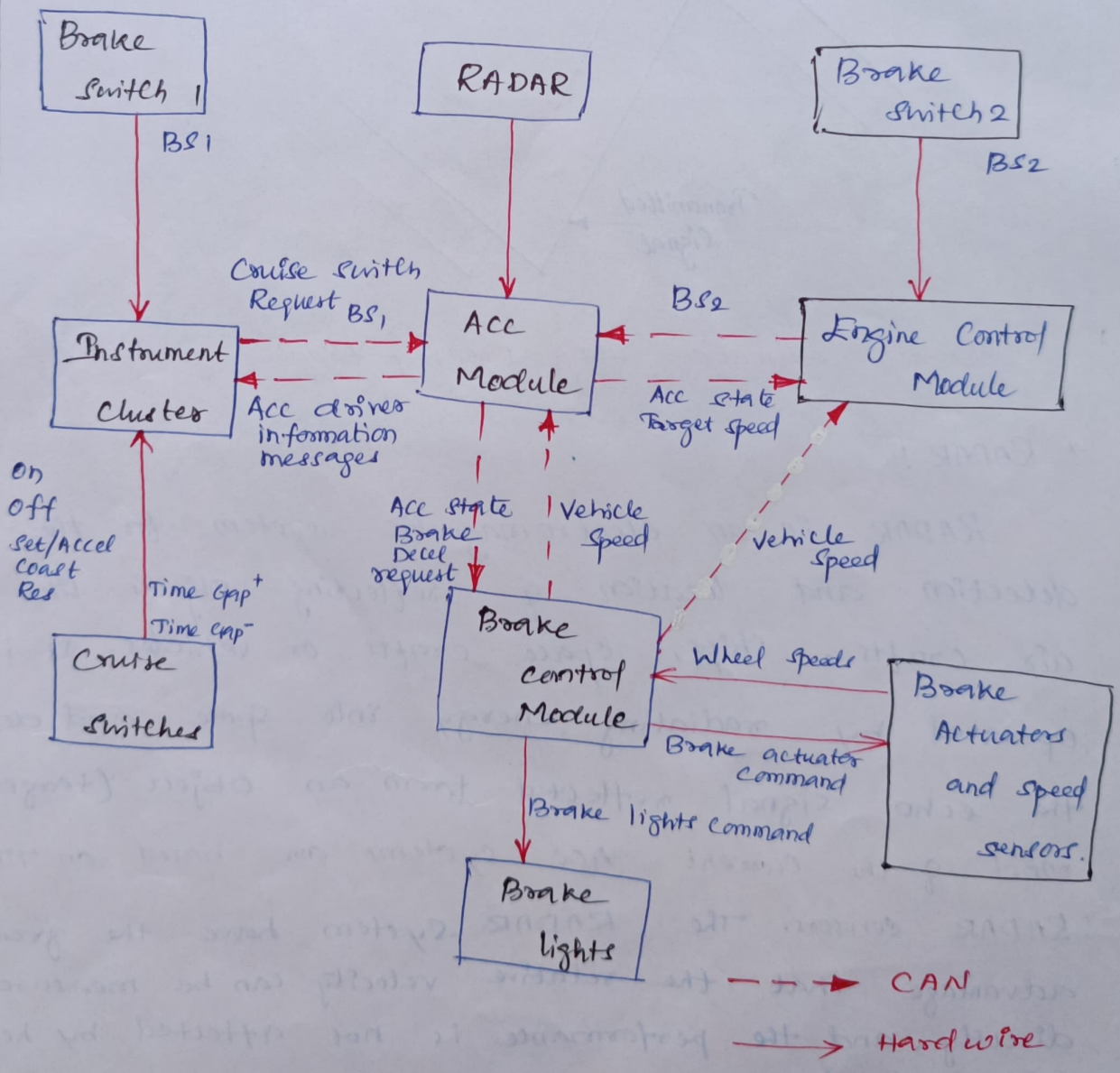
LIDAR - (Light Detection and Ranging)

RADAR - (Radio Detection and Ranging)

VISION sensors

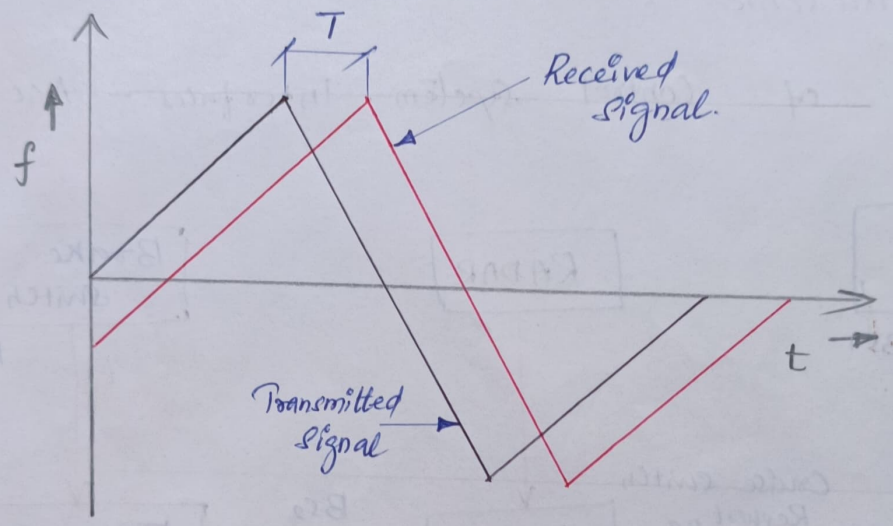
Ultra sonic sensor

Lay out of Control System Interfaces - ACC.



* LIDAR :

The first ACC system introduced by Toyota used this method. By measuring the beat frequency difference between a Frequency Modulated Continuous light wave (FMCW) and its reflection.



Range estimation using FMCW - LIDAR.

* RADAR :

RADAR is an electromagnetic system for the detection and location of reflecting objects like air crafts, ships, space crafts or vehicles. It is operated by radiating energy into space and detecting the echo signal reflected from an object (target). Most of the current ACC systems are based on 77GHz RADAR sensors. The RADAR system have the great advantage that the relative velocity can be measured directly, and the performance is not affected by heavy rain and fog.

xxx ——— xxx ——— xxx