



## Automotive Vehicles AEL ZC441

BITS Pilani
Pilani Campus

Pooja Lakshmi D, BTech Mechanical Engg, MTech Design Engg Adjunct Faculty– Automotive Vehicles (Sem I)



# **Automotive Vehicles Lecture 1**

## innovate achieve lead

### **Course Description**

- Automotive Chassis Layout
- Frame and body Construction
- I.C. Engine Construction and Components
- Engine Cooling and Lubrication System
- Clutches
- Transmission System
- Drive Line System
- Steering System
- Suspension
- Shock Absorber System
- Braking System
- Automotive Vehicle Performance.



## **Course Objective**

No	
CO1	To study of main components/systems of an automobile, such as an engine, transmission, drive-axle system, suspension system, brake system, etc.
CO2	Understanding the fundamental working principles of different systems.
CO3	To learn the performance analysis along with working, and important aspects of various components of automotive vehicles
CO4	To get acquainted with advanced concepts through projects, assignments which will be conducted during the semester

### **Books and Other Resources**

#### Text Book(s)

TB1	N. K. Giri, Automotive Mechanics, Khanna Publishers, Eighthedition
TB2	Kripal Singh, Automobile Engineering, - Vol. I & II, Standard Publishers & Distributors

### Reference Book(s) & other resources

RBa	V. Ganeshan, Internal Combustion Engines, Tata McGraw-Hill Education
RBb	Joseph Heitner, <i>Automotive Mechanics – Principles and Practice</i> , - Affiliated East West Press, 2 <sup>nd</sup> edition, 1980
RBc	K.K. Jain, R.B. Asthana, Automobile Engineering TTTI Bhopal - Tata McGraw-Hill
RBd	S. Srinivasan, Automotive Mechanics,- Tata McGraw-Hill Education
RBe	Sudhir Kumar Saxena, Automobile Engineering, University science Press,2009

## **Learning Outcomes**

No	
LO1	To be able to recognize and identify different vehicle systems and components.
LO2	To be able to analyze the functions and evaluate the performance of vehicle systems.
LO3	Understanding importance of each system and how it may affect safety, reliability and performance of vehicle.
LO4	Apply technical knowledge and skills necessary to remove, replace mechanical related small components.

## **Syllabus**

Lect No.	Learning Objectives	Topics to be covered	Reference to Text
1	An introduction to automobiles	Overview of the course and evaluation scheme Development of automobiles, General classification, Basic structure and components of automobile	1TB1,1TB2
2	The chassis Construction and Body	Classification, Conventional construction, Sub frames, Frame less constructions, Classification of body, Numerical problems on chassis member bending.	11TB1, 1 TB2
3	Reciprocating Engine Construction and basics	Constructional details, Calculation of displacement velocity and acceleration of piston and connecting rod, Working of 2and 4 stroke engines.  Numerical problems on the above topics	3TB1
4	Cooling systems	Need. Variation of gas temperature. Piston temperature distribution. Theory of engine heat transfer and correlation. Parameters affecting engine heat transfer. Air-cooled systems.	8TB1, 12RBa
5	Cooling systems	Types of water-cooling systems. Radiators. Fans. Correlation for the power required for engine cooling. Numerical problems on the above topics	8TB1, 12RBa
6	Lubrication systems	Causes of engine friction. Function of lubrication. Mechanism of lubrication. Journal bearing lubrication.	7TB1, 11RBa
	Lubrication systems	Types of lubrication systems. Lubrication of engine components.	7TB1, 11RBa
7	Clutch	Definition of clutch, requirements, classification, principle of working of friction clutches, Driving system and Plate clutch (uniform pressure and uniform wear).	14TB1, 3TB2

## **Syllabus**

Lect No.	Learning Objectives	Topics to be covered	Reference to Text
8	Clutch	Comparison of spring and diaphragm clutch, Cone clutch (uniform pressure and uniform wear).	14TB1, 3TB2
	II II II ('Y)	Energy lost by plate clutch during engagement. Centrifugal clutch. Frction materials and properties, Numerical problems on the above topics	14TB1, 3TB2
9	Brakes	Fundamentals of brakes, Braking of vehicle. Heat generated due to braking operation. Theory of Internal expansion brake.	18TB1, 10,11TB2
	IRrakae	Hydraulic brakes. Hand or parking brakes. Braking of vehicle moving in a curved path. Numerical problems on the above topics	18TB1, 10,11TB2
10		Fundamentals of gear train, need of gear box, types of gear boxes, Torque and tooth load in epicyclic gear trains. Sliding mesh and constant mesh gears.	15TB1, 4TB2
10	u-ear nox	Epicyclic gears and hydra-matic transmission. Numerical problems on the above topics	15TB1, 4TB2
	Differential and rear axle	Differential. Rear axle. Axle shaft. Axle housing. Numerical Problems	16TB1, 6TB2
11	Propeller shaft, Universal joint	Types of driving shafts. Mechanics of Hotchkiss and torque tube drives. Slip joint. Hook's joint.	16TB1, 6TB2
12	System	Object and basic requirement, Functions and types of suspension spring, Shock absorber, Independent Suspension, Stabilizer, Interconnected suspension systems, Numerical Problems on spring design	12 TB1,7TB2



### Syllabus & Evaluation scheme

Lect No.	Learning Objectives	Topics to be covered	Reference to Text
40	Steering	Ackerman steering gear. Devis steering gear. Turning circle radii. Standard steering gears. Power steering.  Numerical problems on the above topics	17TB1, 8TB2
1	Wheels and Tyres	Types of wheels. Design consideration of wheels. Wheel alignment.	13TB1, 9TB2
1	IPAMANCA	Forces and couples on wheel, Vehicle drag, Power for propulsion, Traction and tractive efforts, Stability of vehicle on slope.	20TB1
	Miscellaneous Topics	Accessories and vehicle safety	12,13,14 TB2
1 15-16	Revision and Review	Discussion on the topics studied for Mid semester and comprehensive exam	

No	Name	Туре	Duration	Weight	Day, Date, Session, Time
EC-1	Assignments/Quizzes	Online	-	20%	TBC
EC-2	Mid-Semester Exam	Closed Book	2 hours	30%	TBC
EC-4	Comprehensive Exam	Open Book	3 hours	50%	TBC

Legend: EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

## **Today's Topic**

Lect No.	Learning Objectives	Topics to be covered	Reference to Text
1	An introduction to automobiles	Overview of the course and evaluation scheme Development of automobiles, General classification, Basic structure and components of automobile	1TB1,1TB2
2	The chassis Construction and Body	Classification, Conventional construction, Sub frames, Frame less constructions, Classification of body, Numerical problems on chassis member bending.	11TB1, 1 TB2
3	Reciprocating Engine Construction and basics	Constructional details, Calculation of displacement velocity and acceleration of piston and connecting rod, Working of 2and 4 stroke engines.  Numerical problems on the above topics	3TB1
4	Cooling systems	Need. Variation of gas temperature. Piston temperature distribution. Theory of engine heat transfer and correlation. Parameters affecting engine heat transfer. Air-cooled systems.	8TB1, 12RBa
5	Cooling systems	Types of water-cooling systems. Radiators. Fans. Correlation for the power required for engine cooling. Numerical problems on the above topics	8TB1, 12RBa
6	Lubrication systems	Causes of engine friction. Function of lubrication. Mechanism of lubrication. Journal bearing lubrication.	7TB1, 11RBa
	Lubrication systems	Types of lubrication systems. Lubrication of engine components.	7TB1, 11RBa
7	Clutch	Definition of clutch, requirements, classification, principle of working of friction clutches, Driving system and Plate clutch (uniform pressure and uniform wear).	14TB1, 3TB2

### An Introduction to Automobile

- Development of Automobile
- General Classification
- Basic Structure
- Components of Automobile



### What is Automobile!!!

- A self-propelled vehicle used for transportation of goods and passengers on land is called an automobile or automotive or motor vehicle
- An Automobile is a wheeled vehicle carrying its own motive power unit



- 1769 Captain Nicholas Cugnot built first Steam Engine tractor in France
- 1802 Richard Trevitluck built first practical steam vehicle using crankshaft
- 1805 Olivar Evan designed Vehicle with 4 wheels and body as a flat boat
- 1821 Julis Griffith built first comfortable steam powered vehicle
- 1805 & 1902 Two outstanding Success were Stanley Steamer (160 kmph) and White steam car
- 1860 Elenne Lenoir demonstrated Operation of Internal Combustion Engine

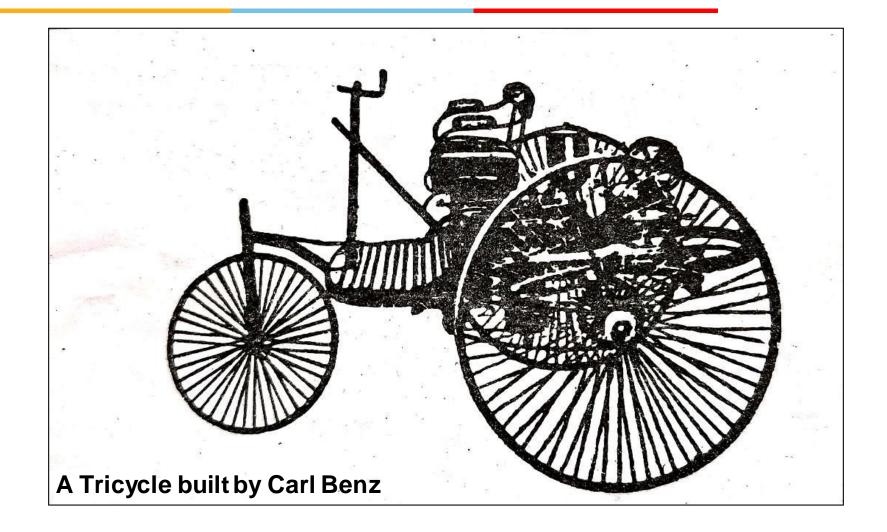


- 1862 Beau de Rcohas laid down conditions to obtain maximum efficiency
- 1863 Lenoir built Automobile propelled by gas engine and drove about 11 km
- 1876 Otto embodied Four stroke cycles using coal gas called as Otto cycle
- 1880 Dugald Clark invented two stroke cycle Engine
- 1886 Gottlieb Daimler patented IC Engine for Bicycle
- 1888 Karl Benz produced first three wheeled Automobile with Otto cycle Petrol engine
- 1892 Charles E. Duryea and Frank Duryea operated First Gasoline powered vehicle

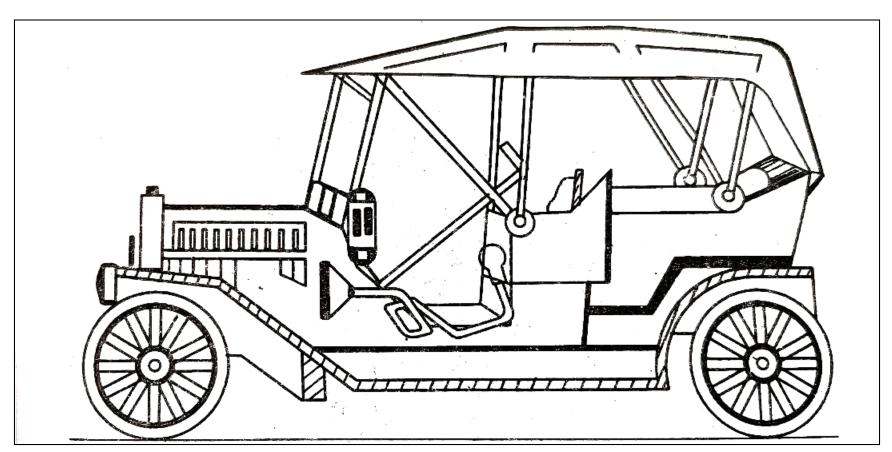


- 1893 Karl Benz produced first Four wheeled Automobile
- 1895 Hendry Ford constructed Quadricycle driven by two cylinder gasoline engine
- 1900 First front mounted Power units constructed in Columbia
- 1901 Oldsmobile company produced 4000 units, Cadillac produced 1895 units, Brick Motor company produced 750 units, Ford produced 20000 units of T Model
- 1906 Production and sales become a real business
- 1920 William Morris developed low priced Motor car
- 2005 63 Million cars and Light trucks produced worldwide





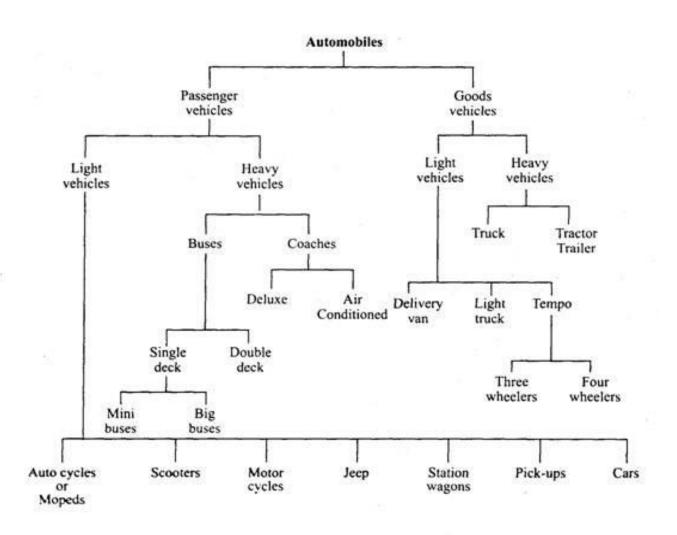




A typical 1910 Car

## General Classification of Automobile





# **General Classification of Automobile – Type I**



1. Use	4. Fuel Used	7. Drive
- Mopeds	- Petrol	- LHD
- Motor Cycles, Scooters	- Diesel	- RHD
- Cars , Jeeps		- Front Wheel
- Buses and Trucks	5. Body Style	- Rear Wheel
	<ul> <li>Closed Cars</li> </ul>	- All wheel
2. Capacity	- Open Cars	
- Heavy Transport Vehicles	<ul> <li>Special Style</li> </ul>	8. Transmission
<ul> <li>Light Transport Vehicles</li> </ul>		- Manual
	6. Wheels	<ul> <li>Semi Automatic</li> </ul>
3. Make & Model	<ul><li>6. Wheels</li><li>Two wheelers</li></ul>	<ul><li>Semi Automatic</li><li>Fully Automatic</li></ul>
<ul><li>3. Make &amp; Model</li><li>Bajaj Pulsar</li></ul>		
	- Two wheelers	- Fully Automatic

# General Classification of Automobile – Type II



- 1. Single unit Vehicles or Load carriers
  - Conventional Four wheel Type
  - Two axle design
  - Front axle is steering non-driving axle
  - Rear axle is driving axle

#### 2. Articulated Vehicles

- Three wheeler
- Single steering wheel in front
- Conventional rear driving axle

### 3. Heavy Tractor Vehicles

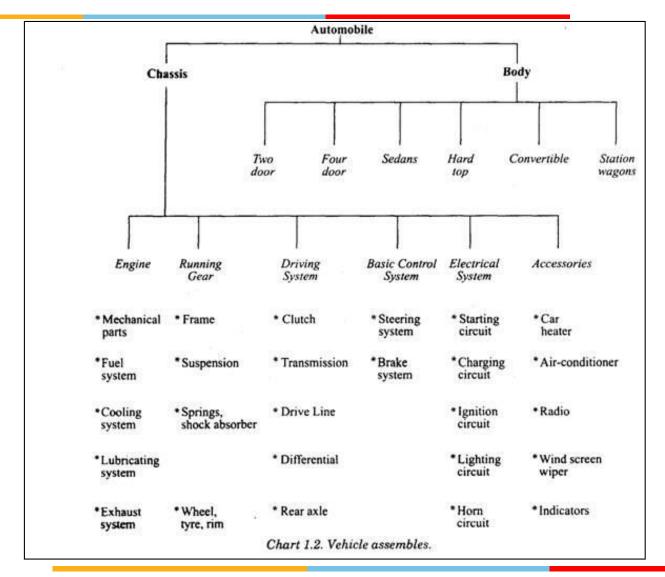
- To move heavy loads
- Operate as Puller / Pusher

### **Components of Automobile**

- > The Basic Structure
- The Power Plant
- ➤ The Transmission System
- The Auxiliaries
- > The Controls
- > The Superstructure

## innovate achieve lead

### **Components of Automobile**





### 1. Frame (Two distinct form of Construction)

- The Conventional steel frame where all Mechanical units are attached

-The Integral or Frameless construction, in which Body structure is

designed to combine body and frame

#### <u>Advantages of Frameless Construction:</u>

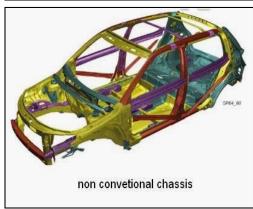
- Reduced Weight
- Saving in Fuel consumption
- Less Manufacturing cost
- Provide Safety to customers absorbing Shock
- Increased Stability

construction

#### <u>Disadvantages of Frameless Construction:</u>

- Reduced Strength and durability
- Economical only in Mass Production
- Increased cost of Repairs
- Topless cars are difficult to design with frameless





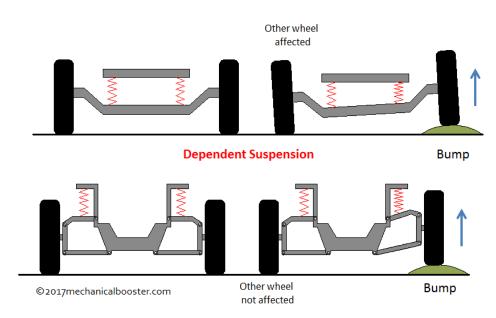


#### 2. Suspension

- To prevent Road shocks from being transmitted to Vehicle components
- To safeguard components from road shocks
- To preserve the stability of the vehicle in pitching or rolling while in motion.

#### **Two Types of Suspension:**

- Conventional System (Road springs attached to a Rigid beam axle)
- Independent System (No Rigid axle beam and each wheel is free to move)



Independent Suspension

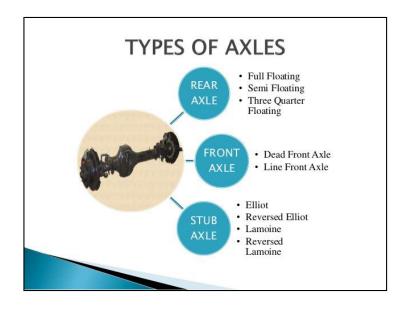


#### 3. Axles

- Weight carrying Portions of the axles, supported at ends, loaded at two intermediate Points
- Subjected to following loads
  - Vertical loads at the spring Centre's due to Weight of the vehicle
  - A fore and aft load at the wheel Centre due to driving or braking effort
  - 3. The torque reaction due to drive or brakes
  - 4. A side thrust at the radius of the tire due to centrifugal force when rounding a curve

#### Types of Live Real Axles:

- Fully floating type
- Semi floating type
- Three quarter floating type





#### 4.Wheels

- Wire Spoked wheels (Sports car)
- Steel Wheel
- Light Alloy wheels (Luxury cars)

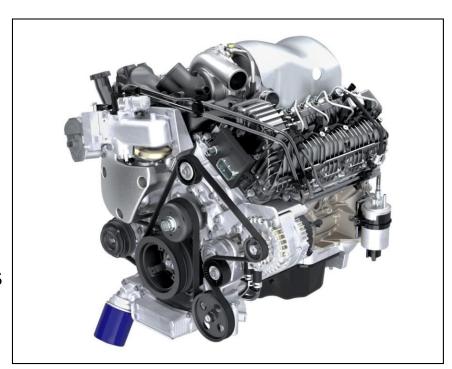




## Components - The Power Plant

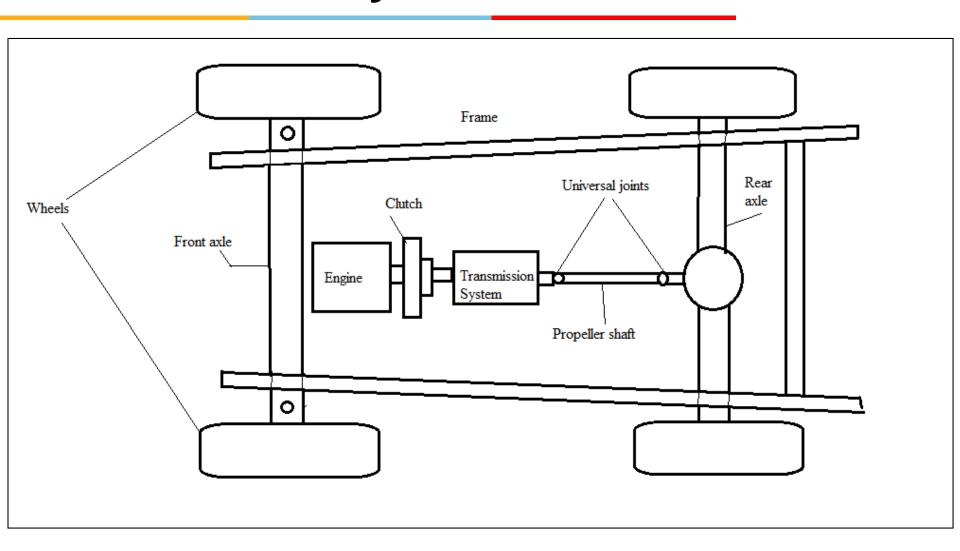


- Provides the Motive power for all functions
- Consists of Internal Combustion Engine (Spark or Compression Ignition)
- Gas turbines also used to provide Power to cars
- Electric Motors powered by batteries used in many Automobiles
- Combination of IC Engines and Electric motors are used in Hybrid Vehicles
- Solar Energy Power system
- Fuel Cells (Zero Emission)



## **Components – The Transmission System**





### **Components – The Transmission System**



### **Components of Transmission System:**

- Clutch Engage / Disengage the drive from the Engine to Road wheels gradually
- 2. Gear box Variation between Engine and Road wheels
- Bevel Pinion & Crown Wheel Permanent Reduction in speed
- 4. Universal Joints Relative movement between Engine and driving wheels
- 5. Differential While taking turn, driving wheels must turn at different speeds
- 6. Propeller Shaft To transmit the torque output from gear box to Axle

# Components – The Transmission System

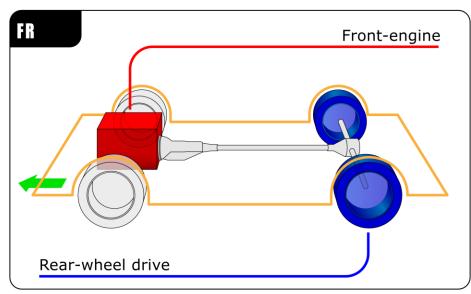


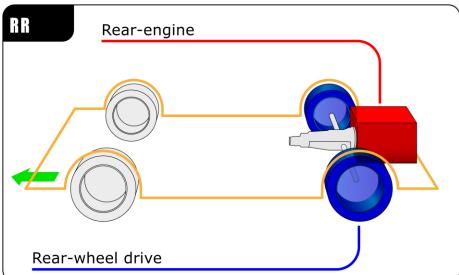
### **Functions:**

- To disconnect the Engine from the roadwheels when desired
- ❖ To connect the engine to the driving wheels without shock
- To vary the leverage between the Engine and the driving wheels
- To reduced the Engine speed permanently
- To turn the drive through a right angle
- To Flex road springs causes relative movement between Engine and the driving wheels

## innovate achieve lead

### Front Engine Vs Rear Engine







### Front Engine Vs Rear Engine

#### Advantages (Front Engine)

- Low chassis height
- Lighter construction
- Better Road adhesion
- Reduced risk of driver losing control
- Increased interior space
   Disadvantages
- Front wheels i.e. driving wheels will have to be steered also, which makes whole arrangement complicated
- Less traction

#### Advantages (Rear Engine)

- Better traction
- Decrease chassis height
- Better visibility
- Compact

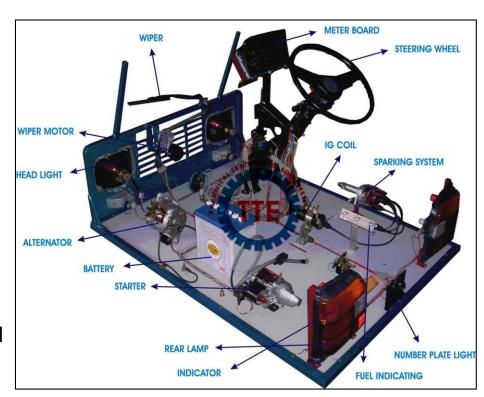
#### Disadvantages

- Low interior space
- Increase weight in rear cause unstable at higher speed
- Reduced cooling efficiency
- Difficult to access at service /repair
- Risk in collision due to fuel tanks in front

## innovate achieve lead

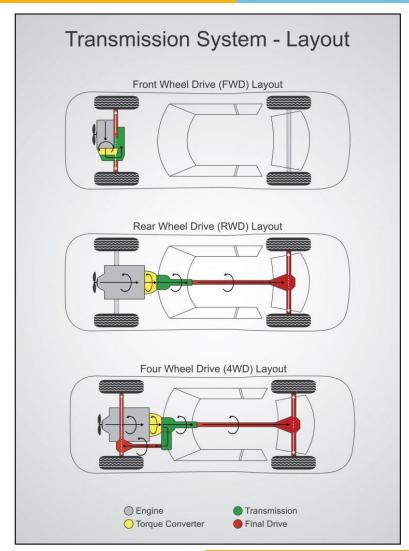
### **Components - The Auxiliaries**

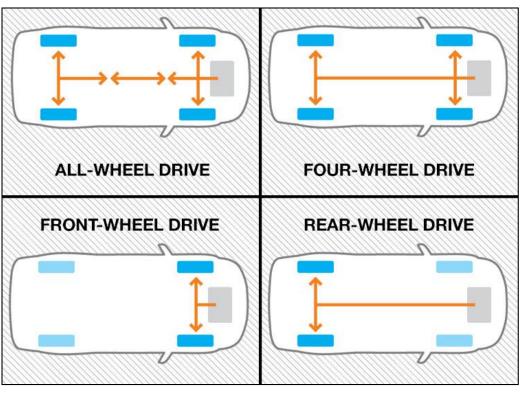
- Supply system- Battery & Generator
- 2. Starter
- Ignition system- Battery & Magneto Ignition
- 4. Ancillary devices
  - Driving lights (Head , Side, Tail lights
     & Number plate illumination)
  - Signaling (Horn, Direction indicators
     & Brake light)
  - Other lights (Interior roof light, Panel light & Reverse light)
  - Miscellaneous (Radio, Heater, Fan, Electric fuel pump, Electric wind screen wiper)



## Front Wheel / Rear Wheel / All Wheel Drive



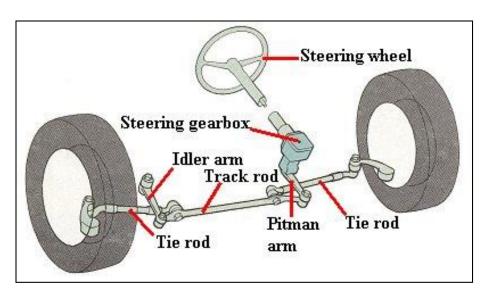


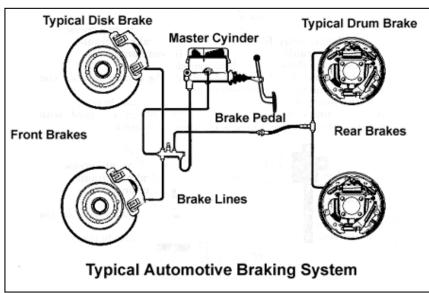




### **Components - The Controls**

- 1. Steering system
- 2. Braking system

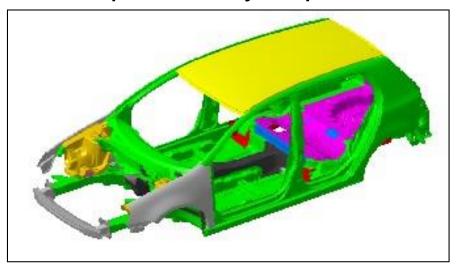




## Components - The Super Structure



- Body attached to the frame, incase of farmless construction
- Body performs the function of chassis and frame
- Body contains passenger and luggage space besides engine compartment
- Shape of body depends on ultimate use of vehicle



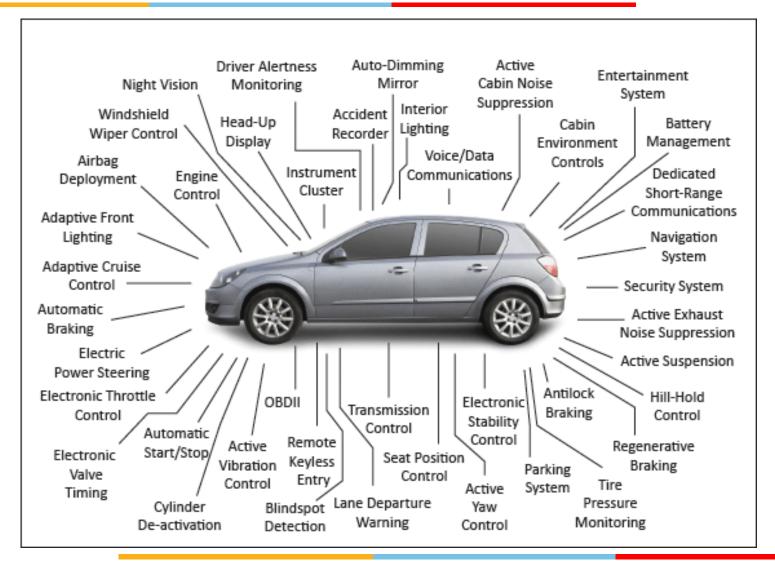


### **Vehicle Design Considerations**

- 1. Design Objectives
- 2. Design Parameters (Acceleration, Speed, Weight, Limitations)
- 3. Durability (Temperature, Lubrication, Period)
- 4. Cost (Materials)

lead

### The CAAAR!!!



## Thank You!!!!