Q.No.1.

a. ***Give the classification of motor vehicle on the basis of location of power plant***

Ans: The engine is typically placed in one of three locations. In the vast majority of vehicles, it is located as the front of the vehicle, in front of the passenger compartment. Front-mounted engines can be positioned either longitudinally or transversely with respect to the vehicle.

The second engine location is a mid-mount position between the passenger compartment and rear suspension. Mid-mount engines are normally transversely mounted. The third, and least common, engine location in the rear of the vehicle. The engines are typically opposed-type engines.

Each of these engine locations offers advantages and disadvantages:-

Front Engine Longitudinal

In this type of vehicle, the engine, transmission, front suspension, and steering equipment are installed in the front of the body, and the differential and rear suspension are installed in the rear of the body. Most front engine longitudinal vehicles are rear-wheel drive. Some front-wheel-drive cars with a transaxle have this configuration, and most four-wheel-drive vehicles are equipped with a transfer case and have the engine mounted longitudinally in the front of the vehicle.

Total vehicle weight can be evenly distributed between the front and rear wheels with this configuration. This lightens the steering force and equalizes the braking load. With this design, it is possible to independently remove and install the engine, propeller shaft, differential, and suspension. Longitudinally mounted engines require large engine compartments. The need for a rear-drive propeller shaft and differential also cuts down passenger compartment space.

Front Engine Transverse

Front engines that are mounted transversely sit sideways in the engine compartment. They are used with transaxles that combine transmission and differential gearing into a single compact housing, fastened directly to the engine. Transversely mounted engines reduce the size of the engine compartment and overall vehicle weight.Transversely mounted front engines allow for down-sized, lighter vehicles with increased interior space. However most of the vehicle weight is toward the front of the vehicle. This provides for increased traction by the drive wheels. The weight also places a greater load on the front suspension and brakes.

Mid-engine Transverse

In this design, the engine and drive train are positioned between the passenger compartment and rear axle. Mid-engine location in used in smaller, rear-wheel-drive, high-performance sports cars for several reasons. The central location of heavy components results in a center of gravity very near the center of the vehicle. This vastly improves steering and handling. Since the engine is not under the hood, the hood can be sloped downward, improving aerodynamics and increasing the driver's field of vision. However, engine access and cooling efficiency are reduced. A barrier is also needed to reduce the transfer of noise, heat, and vibration to the passenger compartment.

b. ***Explain Aerodynamic drag and aerodynamic lift with moments acting on the vehicle***

Ans: A breakdown of the factors causing aerodynamic drag. Aerodynamic drag of rotating wheels may be omitted in the consideration of utilitarian or utility vehicles as it only gives a component of drag without considering at speeds above 150km/h (93 mph).the total aerodynamics drag of a vehicle includes many factors such as profile drag, induced drag, skin friction drag, interference drag & cooling and ventilation system drag.

The total aerodynamic drag can be written in usual form:

$P_x = C_x . \rho . v^2 . A/2$

Where C_x = dimensionless drag coefficient, ρ = air density

V = velocity of the vehicle & A = cross-sectional area of the vehicle

When viewed from front

Skin friction drag

Drag due to tangential stress exerted on the surface of the body as the viscous fluid

Slips as a body (i.e.), the drag caused due to the friction between the aircraft's outer surface & air.

Friction forces between an object & air through which it is moving produces skin friction drag. The magnitude of skin friction drag depends on surface area of the aircraft. The whole surface of the aircraft experiences a surface (or) skin friction drag as it moves through the air

Induced drag

The drag caused due to induced lift.

Induced drag is a bi-product of lift and is closely related to the angle of attack. Induced drag is separate from the parasite drag. Due to the development of lift a wing will have both induced and parasite drag. Actually induced drag is directly proportional to lift and inversely proportional to speed.

Effects of induced drag:

(i) Induced drag increases with increase in weight

(ii) Induced drag decreases with wing span i.e., high aspect ratio reduces induced drag

(iii) Speed increases, induced drag decreases

Interference drag

It is caused by interference (i.e.) a term applied to the aerodynamic influence of bodies & parts of an aircraft on one another. When the aircraft parts are far apart the interference drag effect will be less. If gap between a biplane wing decreases then interference increases.

Total drag is greater than the sum of the drag on the individual parts of the aircraft. This is due to the flow interference at the junction of various surface, such As the wing, fuselage junction, tail fuselage junction or engine wing junction. This Flow interference creates additional drag which is interference drag. It is not directly associated with production of lift i.e., it is a parasite drag. Suitable fairing and streamlining of shapes to control local pressure gradient that can minimize interference drag. Fairing is a part of the skin of an aircraft added to encourage streamline flow, thereby reducing eddies. Hence, decreasing drag.

At zero speed, there is no relative motion between the aircraft and the air. Therefore there is no parasite drag. As the speed increases skin friction drag, form drag and interference drag increases about half the parasite drag on aircraft due to the wing

Q.No 2. a. ***Explain the different types of materials used for passenger car and bus***

Ans: *Plastics*

There are two types of plastics: thermoplastics and thermosetting polymers. Thermoplastics are the plastics that do not undergo chemical change in their composition when heated and can be molded again and again; examples are polyethylene, polypropylene, polystyrene, polyvinyl chloride and polytetrafluoroethylene.

Thermo sets can melt and take shape once; after they have solidified, they stay solid. The raw materials needed to make most plastics come from petroleum and natural gas.

Polypropylene (PP) - car fenders (bumpers)

Polyamides (PA) (Nylons) - Fibers, under-the-hood car engine moldings

Polycarbonate/Acrylonitrile Butadiene Styrene (PC/ABS) - A blend of PC and ABS that creates a stronger plastic Used in car interior and exterior parts

Polyurethanes (PU) - Cushioning foams, thermal insulation foams, surface coatings, for instance the most commonly used plastic found in cars).

Plastic fuel tanks are made from high density polyethylene (HDPE), a strong, lightweight material which has allowed manufacturers to substantially lower the net weight of the automobile. Since the mid-1980s, automakers have been displacing coated-steel fuel tanks with plastic ones. During the early 1990's, approximately 2.7-3 million cars and trucks built in North America used nonmetallic tanks. At this time it represented 22-25% of the market, compared to 16% in the late 1980's. Experts dealing with automotive designs predict plastic tanks will capture 60% of the North American market by the end of 2001. This can be considered as a worst-case scenario for the steel industry if it fails to provide a cost-effective steel alternative that meets all of the performance criteria.

Rubbers

Natural rubber is extracted from the Hevea brasiliensis tree in South America, Indonesia and Sri Lanka. The latex rubber is removed from the trees via a tap and transported to factories where it is used in production. Synthetic rubber is made through a process called polymerization and the production method is similar to that of plastic. Both natural and synthetic rubber products can be recycled to form new products or to repair damaged ones. Rubber often contains additives such as polymers, softeners, fire retardants and activators to improve the finished product.

Natural rubber is often used in vehicles like large trucks and trailers.

Butyl rubber is used for inner tube manufacturing.

Retreading tires is another popular method of recycling rubber products and some vehicles, such as buses and large trucks, can have their tires retreaded up to six times before they must be discarded.

Rubbers are also used in Rubber bushings, Engine mountings, Hose pipes, brake parts

ABS plastic – Most original equipment manufacturers create spoilers produced by casting ABS plastic with various admixtures, which bring in plasticity to this inexpensive but fragile material. Frailness is a main disadvantage of plastic, which increases with product age and is caused by the evaporation of volatile phenols.

Fiberglass – Used in car parts production due to the low cost of the materials. Fiberglass spoilers consist of fiberglass cloth in filled with a thermosetting resin. Fiberglass is sufficiently durable and workable, but has become unprofitable for large scale production due to the amount of labor.

Silicon – More recently, many auto accessory manufacturers are using silicon-organic polymers. The main benefit of this material is its phenomenal plasticity. Silicon possesses extra high thermal characteristics and provides a longer product lifetime.

Carbon fiber – Carbon fiber is light weight, durable, but also a very expensive material. Due to the very large amount of manual labor, large scale production cannot widely use carbon fiber in automobile parts production currently.

b) Explain the following with load path: Bending load, Torsion Load, Lateral Load, Breaking Load

Q.No. 3. *a.* ***Explain latest trends in design and manufacturing***

Ans: Latest trends in design and manufacturing

ULSAB Design

The Ultra light Steel Auto Body (ULSAB) Programme is an intensive, multi-phase study to demonstrate steel's capability to reduce substantially the weight of a vehicle's body structure and, at the same time, ensure safety with improved comfort and driving performance, all at affordable cost.

ULSAB resulted in the design and engineering of a lightweight, efficient steel body structure that achieves impressive mass savings and significant performance improvements, while retaining affordable cost to manufacture.

ULSAB achieves:

Mass savings of 25% over the benchmark at no cost penalty

80% improvement in torsional rigidity

52% improvement in bending rigidity

58% improvement in first body mode

Meets all mandated crash requirements

Tailored Blanks

Tailored blanks are made by welding together flat steel sheets of different thicknesses, grades and coatings.

Joining materials of different thickness, strength or coating type can produce a 'tailored blank' ready for pressing.

Lasers are ideal for this application as they both cut individual blanks and weld the component parts to form a finished tailored blank.

These products, widely used in automotive chassis and body-in-white (BIW) components, decrease the weight of the vehicle and improve safety by enhancing crash performance.

At the same time, laser welded blanks have been shown to reduce the total cost of the vehicle structure.

Benefits of Tailored Blanks

Cost saving.

Weight reduction.

Increased material utilization.

Improved corrosion resistance.

Less press tooling required.

Production of Patchwork Blanks: Spot or laser welding

First the patch is shaped either by punching or laser cutting depending on shape and size.

Three methods can be used to join the patch to the basic blank:

Spot welding

Laser welding

Adhesive bonding

Spot Welding

To ensure we achieve the best possible results from spot welding, we choose from two options depending on requirements.

In the first of these, the patch is held in position on the basic blank using just a few spot welds.

Joining of the two parts is completed after forming by additional spot welds.

The second option involves considerably more spot welds prior to forming, eliminating the need for subsequent welding operations.

Features of spot welding:

Sequential spot welding

Finish welded

Limited control of forming behavior

Q.No. 3. *b.* ***Explain various safety features in body, which can be incorporated during design stage.***

Ans: Crashworthy systems and devices prevent or reduce the severity of injuries when a crash is imminent or actually happening. Much research is carried out using anthropomorphic crash test dummies.

Seatbelts limit the forward motion of an occupant, stretch to slow down the occupant's deceleration in a crash, and prevent occupants being ejected from the vehicle.

Airbags inflate to cushion the impact of a vehicle occupant with various parts of the vehicle's interior.

Laminated windshields remain in one piece when impacted, preventing penetration of unbelted occupants' heads and maintaining a minimal but adequate transparency for control of the car immediately following a collision. Tempered glass side and rear windows break into granules with minimally sharp edges, rather than splintering into jagged fragments as ordinary glass does.

Crumple zones absorb and dissipate the force of a collision, displacing and diverting it away from the passenger compartment and reducing the impact force on the vehicle occupants. Vehicles will include a front, rear and maybe side crumple zones (like Volvo SIPS) too.

Side impact protection beams.

Collapsible universally jointed steering columns, (with the steering system mounted behind the front axle - not in the front crumple zone), reduce the risk and severity of driver impalement on the column in a frontal crash.

Pedestrian protection systems.

Padding of the instrument panel and other interior parts of the vehicle likely to be struck by the occupants during a crash.

Q.No. 4. *a. Explain the various loads acting on the chassis frame.*

Ans: Various loads acting on the frame are

1. Short duration Load - While crossing a broken patch.
2. Momentary duration Load - While taking a curve.
3. Impact Loads - Due to the collision of the vehicle.
4. Inertia Load - While applying brakes.
5. Static Loads - Loads due to chassis parts.
6. Over Loads - Beyond Design capacity.

Q.No. 4. *b* ***Explain the various components mounted on the chassis frame of vehicle***

Ans: Various components mounted on chassis frame are

1. Engine or power plant
2. Clutch
3. Gear box
4. Steering mechanism
5. Propeller shaft
6. Differential
7. Leaf spring
8. Fuel tank

Q.No. 5. *a. what is the requirement of design of child seat?*

Ans: Child safety seats (sometimes referred to as an infant safety seat, a child restraint system, a restraint car seat, or ambiguously as car seats) are seats designed specifically to protect children from injury or death during collisions. Automobile manufacturers may integrate child safety seats directly into their vehicle's design. Most commonly, these seats are purchased and installed by consumers. Many regions require children defined by age, weight, and/or height to use a governmentally approved child safety seat when riding in a vehicle. Child safety seats provide passive restraints and must be properly used to be effective.
Though there are hundreds of variations of makes and models in the world of child safety seats, the materials used in the manufacturing process are basically the same across the board. Factories in which the seats are put together receive loads of a tough

plastic called polypropylene in the form of tiny pellets. This tough plastic is very hard to crack, so it only makes sense that it would be used to form the base of all child safety seats. This plastic is universal in the make of all restraints made for children. A company by the name of Indiana Mills is responsible for manufacturing the adjustment mechanisms and buckles for most child safety seats. Foam makes up the padding of the individual seats, while vinyl and fabrics are used to make up the covers for the seats as well as the harnesses. Among all these products used to make one child safety seat, none are as important as the labels each manufacturer prints according to Federal standards. Printing of these labels is done by subcontracted printers of the manufacturer. These labels must have a permanent place for storage in or on the safety seat and must withstand any tearing so as to make any missing information obvious.

The process of manufacturing the safety seat is what brings all these components together to form a restraint that will increase the safety of a properly restrained child in the case of a motor vehicle accident. In the beginning, the polypropylene is put to use in molding the shells of these seats. Since it arrives in tiny pellet form, these pellets must be melted down and put into a mold of the desired shape of the seat. The seat then moves down an assembly line. On this assembly line, all of the articles from the outside contractors and suppliers are added to the mold. These additions include the foam padding, the fabric covers, the harness, and any buckles or attaching mechanisms. The labels and instructions are also attached at this time. Once it is past the assembly line, the product arrives at the packing department. Here, the seats are wrapped in plastic and packed in cartons which then gets stacked and stored for shipping once ordered All child safety seats are made and manufactured using the same process, however there are different types of seats for children of different size and age with specific guidelines as to how they should be used.

Infant seats - From the time a child is born, they must always ride in an infant seat which is most well known as a rear-facing convertible seat. These seats are designed for a baby that is under twenty pounds and should always remain facing the rear of a vehicle. Seats made specifically for infants are the smallest and have carrying handles for easy carrying and loading. They can be used until the infant is up to 10 through 14.5 kg (22 to 23 lbs.) depending on the instructions specified on each individual model.

Convertible seats - A convertible seat is a child safety restraint that is suggested for the use in the same age and weight range, they are just generally more bulky and can be converted to forward facing child seats as the child grows. Toddlers and pre-school aged children also are to use convertible seats. It is recommended that the child remains facing the rear of the vehicle as long as possible. The American Academy of Pediatrics recently started recommending to begin front-facing at the age of two. Children should ride in a convertible seat with a harness until they outgrow it around the age of four, or weigh at least 29.5 kg (65 lbs.).

Booster seats - Children over 1.2 metres (4 feet) in height and between the ages of eight and twelve now upgrade to booster seats. These seats are also front facing and are designed to raise children up so that the belts made for adults fit properly. By this age and size, the child has completely outgrown any rear-facing seat. From the height of 1.4 metres (4 feet 9 inches) and the ages of eight to twelve, children may have outgrown their booster seats and can be permitted to use regular adult seat restraints. It is suggested that, until the age of thirteen, the child remains in the back seat.

Q.No. 5. *b.* Explain CAE Analysis and Crash Analysis

Ans: CAE Analysis

In general, there are three phases in any computer-aided engineering task:

Pre-processing – defining the model and environmental factors to be applied to it

Analysis solver (usually performed on high powered computers)

Post-processing of results (using visualization tools)

This cycle is iterated, often many times, either manually or with the use of commercial optimization software

CAE in the automotive industry

CAE tools are very widely used in the automotive industry.

In fact, their use has enabled the automakers to reduce product development cost and time while improving the safety, comfort, and durability of the vehicles they produce.

CAE tools have progressed to the point where much of the design verification is now done using computer simulations rather than physical prototype testing.

Even though there have been many advances in CAE and it is widely used in the engineering field.

Physical testing is still used as a final confirmation for subsystems due to the fact that CAE cannot predict all variables in complex assemblies (i.e. metal stretch, thinning).

Crash Analysis

Crash and occupant safety analysis software must be able to handle large deformations, sophisticated material models (for steel and aluminum, rubbers, foams, plastics, and composites), complex contact conditions among multiple components, and short-duration impact dynamics.

The software must be capable of simulating different types of car crash events: frontal impact, side impact, rear impact, and rollover.

Crashworthiness simulation is less expensive and yields more information than experimental techniques.

Because of its extensive capabilities for handling crashworthiness and occupant safety simulations, LS-DYNA is used worldwide by leading automobile manufacturers and their suppliers.

Applications of Crash Analysis LS-DYNA

LS-DYNA is widely used by the automotive industry to analyze vehicle designs.

LS-DYNA accurately predicts a car's behavior in a collision and the effects of the collision upon the car's occupants.

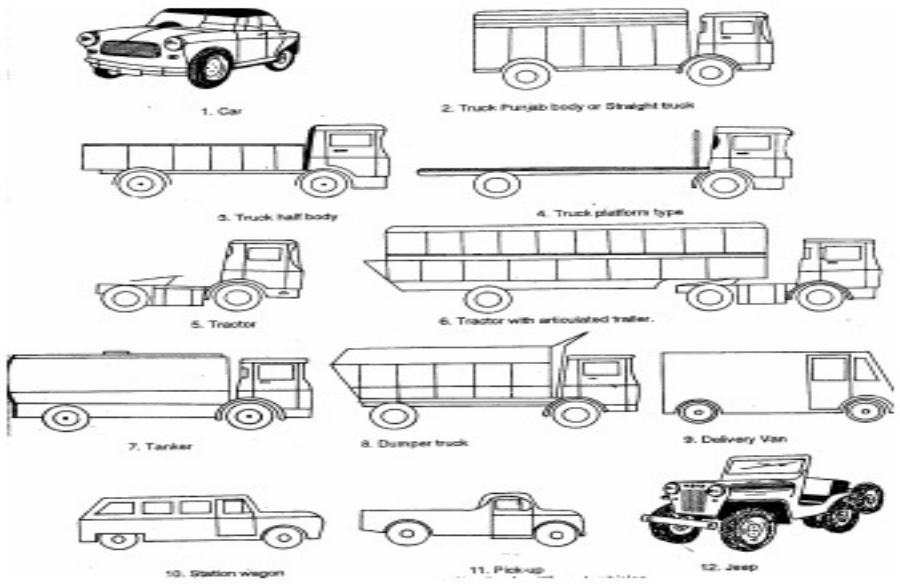
With LS-DYNA, automotive companies and their suppliers can test car designs without having to tool or experimentally test a prototype, thus saving time and expense.

LS-DYNA's specialized automotive features:

- Seatbelts
- Slip rings
- Pretensioners
- Retractors
- Sensors
- Accelerometers
- Airbags
- Hybrid III dummy models

Q.No. 6. *a. Give the features of the following vehicles: Truck, van, bus, coach (Neat sketch)*

Ans:



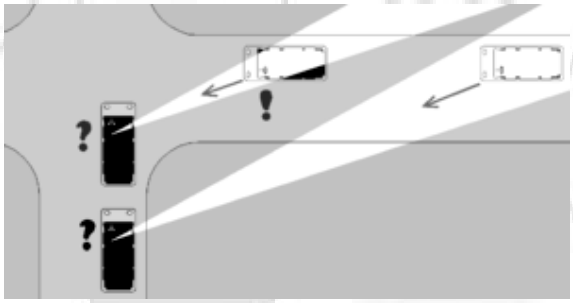
Q.No. 6. *b. Explain the visibility for vehicles*

Ans: Visibility

In transport, driver visibility is the maximum distance at which the driver of a vehicle can see and identify prominent objects around the vehicle. Visibility is primarily determined by weather conditions (see visibility) and by a vehicle's design. The parts of a vehicle that influence visibility include the windshield, the dashboard and the pillars. Good driver visibility is essential to safe road traffic.

Blind spots

Blind spots may occur in the front of the driver when the A-pillar (also called the windshield pillar), side-view mirror, and interior rear-view mirror block a driver's view of the road. Behind the driver, there are additional pillars, headrests, passengers, and cargo that may reduce visibility. Blind spots are affected directed by vehicular speed, since they increase substantially the faster one goes.



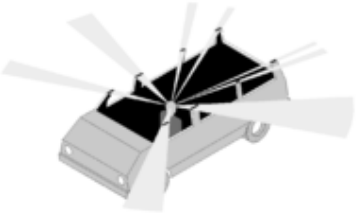
A-pillar blind spot

Forward visibility

This diagram shows the blocked view in a horizontal-plane in front of the driver. The front-end blind spots caused by this can create problems in traffic situations, such as in roundabouts, intersections, and road crossings. Front-end blind spots are influenced by the following design criteria:

- Distance between the driver and the pillar
- Thickness of the pillar
- The angle of the pillar in a vertical plane side view
- The angle of the pillar in a vertical plane front view
- the form of the pillar straight or arc-form
- Angle of the windshield

- Height of the driver in relation to the dashboard
- Speed of the opposite car



40° angle A-pillar bar blind spots

Effects of A-pillar angle on visibility

Most passenger cars have a diagonal pillar as shown in this side view. The angle between the horizon and A-pillar is approximately 40 degrees with a straight pillar that is not too thick. This gives the car a strong, aerodynamic body with an adequately-sized front door.

Vertical A-pillar having small blind spots

Q.No. 7. *a. Write a short notes on following-Bumper*

a) Ans: Bumper

Bumper

An automobile's bumper is the front-most or rear-most part, ostensibly designed to allow the car to sustain an impact without damage to the vehicle's safety systems. They are not capable of reducing injury to vehicle occupants in high-speed impacts, but are increasingly being designed to mitigate injury to pedestrians struck by cars.

Cowling

A cowling is the covering of a vehicle's engine, most often found on automobiles and aircraft.

A cowling may be used:

for drag reduction

for engine cooling by directing airflow

as an air intake for jet engines

for decorative purposes

b) *Q.No. 7.* *b.* Ergonomic Analysis

Ans: Ergonomics is the study of designing equipment and devices that fit the human body, its movements, and its cognitive abilities.

The International Ergonomics Association defines ergonomics as follows:

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.

Ergonomics is employed to fulfill the two goals of health and productivity. It is relevant in the design of such things as safe furniture and easy-to-use interfaces to machines. Proper ergonomic design is necessary to prevent repetitive strain injuries, which can develop over time and can lead to long-term disability.

a) *Q.No. 7.* *c.* Car Body Styles

Ans: Automobiles body styles are highly variable. Some body styles remain in production, while others become less common or obsolete. They may or may not correlate to a car's price, size or intended market classification. The same car model might be available in multiple body styles comprising a model range. Some distinctions, as with four-wheel drive vs. SUV models or minivan vs. MPV models, the distinction between body style and classification can be particularly narrow. While body styles have historical and technical definitions, in common usage such definitions are broad and may be ambiguous. For example, one person may call a 4-passenger sport coupé a "sports car", while another may define a sports car strictly as a two-place vehicle.

Sedan/saloon

A car seating four or more with a fixed roof that is full-height up to the rear window. Known in British English as a **saloon**. Sedans can have 2 or 4-doors. This is the most common body style. In the U.S., this term has been used to denote a car with fixed window frames, as opposed to the hardtop style wherein the sash, if any, winds down with the glass.

Hatchback

Identified by a rear door including the back window that opens vertically to access a storage area not separated from the rest of the passenger compartment. May be 3 or 5-door and 2 to 5 seats, but generally in the US the tailgate isn't counted making it a 2-door and 4-door.

Coupé

A 2-door, 2- or 4-seat car with a fixed roof. Its doors are often longer than those of an equivalent sedan and the rear passenger area smaller; the roof may also be low. In

cases where the rear seats are very small and not intended for regular use it is called a 2+2 (pronounced *"two plus two"*). Originally, a coupé was required to have only one side window per side, but this consideration has not been used for many years.

Convertible

A body style with a flexible textile folding roof or rigid retracting roof — of highly variable design detail — to allow driving in open or enclosed modes.

Station wagon

A car with a full-height body all the way to the rear; the load-carrying space created is accessed via a rear door or doors. Sometimes shortened to just *wagon*.

Van

In North America "van" refers to a truck-based commercial vehicle of the wagon style, whether used for passenger or commercial use. Usually a van has no windows at the side rear (panel van), although for passenger use, side windows are included. In other parts of the world, 'van' denotes a passenger-based wagon with no rear side windows.

Limousine

By definition, a chauffeur-driven car with a (normally glass-windowed) division between the front seats and the rear. In German, the term simply means a sedan.