TNPSC 2026

READY TO LEARN
RLA
LEARN TO ACHIEVE

PDF STUDY MATERIAL

MOTOR VEHICLE INSPECTOR GRADE II

Code : 512

Automobile and Mechanical Engineering

BASED ON DIPLOMA NEW SYLLABUS PATTERN

Covered:
10 UNITS
180+ TOPICS

ENGLISH MEDIUM

RLA ACADEMY

Name

- Unit-01 Basic of Mechanical En...
  Modified 11:28 AM
- Unit-02 Mechanics of Materials
  Modified 11:28 AM
- Unit-03 Production Technology
  Modified 11:28 AM
- Unit-04 Design of Machine Ele...
  Modified 11:28 AM
- Unit-05 Computer Integrated ...
  Modified 11:28 AM
- Unit-06 Automobile Engines
  Modified 11:28 AM
- Unit-07 Chasis & Transmission ...
  Modified 11:28 AM
- Unit-08 Electrical Engineering ...
  Modified 11:28 AM
- Unit-09 Body building Technol...
  Modified 11:28 AM
- Unit-10 Transport Management
  Modified 11:28 AM

Name

- 01. Fluid Mechanics & Properti...
  Modified Aug 24, 2024
- 02. Flow of fluids & Types.pdf
  Modified Aug 24, 2024
- 03. Hydraulic Systems & Comp...
  Modified Aug 24, 2024
- 04. Reciprocating pumps.pdf
  Modified Aug 24, 2024
- 05. Centrifugal pump.pdf
  Modified Aug 24, 2024
- 06. Gear Pump & Vane Pump.pdf
  Modified Aug 24, 2024
- 07. Thermal Engineering.pdf
  Modified Aug 24, 2024
- 08. Properties of Gases.pdf
  Modified Aug 24, 2024
- 09. Expansion of Gases.pdf
  Modified Aug 24, 2024
- 10. Air Cycles-Otto & Diesel cy...
  Modified Aug 24, 2024
- 11. Fuels.pdf

11. Fuels.pdf
Modified Aug 24, 2024

12. Fuel characteristics .pdf
Modified Feb 25

13. Octane Number & Cetane N...
Modified Feb 26

14. Alcohol, LPG and CNG as fu...
Modified Feb 26

15. Lubricants- Viscosity,Flash ...
Modified Feb 26

16. Air compressors - single sta...
Modified Feb 26

17. IC Engine Performance.pdf
Modified Aug 24, 2024

18. Refrigeration – vapour com...
Modified Jan 8

19. Refrigerants.pdf
Modified Feb 26

and behavior of fluids at rest and in motion.

Hydraulics

Hydraulics is the branch of engineering deals with the properties and behavior of water.

1.2. Definition of Fluid

Fluid can be defined as the substance which can flow with or without the aid of force

A fluid may be in three form like as liquid (or) a vapour (or) a gas

1.3. Types of Fluid

Fluids are classified as follows.

1. **Ideal (or) perfect fluid**

   A fluid having density only as property is called Ideal fluid . Ideal fluid one which has no viscosity, surface tension, cohesion and adhesion etc.

Ex. Imaginary fluid

2. **Real fluid (or) Practical fluid**

   A fluid having viscosity, surface tension, cohesion, adhesion and density is called Real Fluid.

   Ex; water, air, lubricating oil

3. **Newtonian Fluid**

   A fluid which obeys Newton's Law of viscosity is called Newtonian fluid.

   Ex; Water, Lubricating oil etc.

4. **Non – Newtonian Fluid**

   A fluid which does not obey Newton's Law of viscosity is called Non-Newtonian fluid.

   Ex; Paints, Plastics etc.

1.4. Properties of Fluid

1. **Density**

   It is defined as the mass per unit volume.

   Density = $\frac{Mass}{Volume}$

   Unit is kg/m^3 Density of water is 1000 kg/m^3 .

2. **Specific weight (weight density)**

   It is defined as the weight per unit volume.

   Specific weight = $\frac{Weight}{Volume}$

   Unit is kN/m^3

Relation between the Specific weight and density is $\mathbf{w = \rho \times g}$

3. Specific volume

It is defined as the volume per unit mass.

Specific volume = $\frac{Volume}{Mass}$ (or) $\frac{1}{Density}$

Unit is m^3/kg.

Relation between the Specific volume and density is $\mathbf{v = 1/\rho}$

4. Relative density (or) Specific gravity

It is defined as the ratio between the density of any liquid to the density of water

5.7. FLUID POWER PUMPS (Hydraulic pumps)

Introduction

A hydraulic pump is a device to pressurize the Hydraulic fluid and to transfer it to the system to do some useful work. Pump converts mechanical energy to hydraulic energy.

Classification of Hydraulic pumps

1. **Positive displacement pump**
   A positive displacement pump is increases the fluid pressure. It is commonly used in Hydraulic system.

2. **Non positive displacement pump**
   A non positive displacement pump is only transfers the fluid.

5.8. Positive displacement pump

i. Gear Pump

1. **External Gear Pump**

The External gear pumps are shown in fig.5.9. The main function of this pump is increases the fluid pressure and transfer the fluid from reservoir to actuator.

Fig. 5.9

This pump consists of two identical spur gears meshing externally. One gear is driven

1.2 PROPERTIES OF PERFECT GASES

1.2.1. Introduction

- If the evaporation from a liquid state of a substance is completed, then it is called a gas.
- Examples: Oxygen, hydrogen, nitrogen, air etc., are regarded as gases within certain temperature limits.
- Partially evaporated liquid is called as vapour.
- It consists of pure gaseous state and suspended liquid particles.
- Vapours will undergo further condensation and evaporation with temperature change or pressure change. Vapours will not obey laws of perfect gases.
- Examples: Steam, carbon di-oxide, ammonia are regarded as vapours.
- A perfect gas or an ideal gas is one which strictly obeys all the gas laws under all conditions of temperature and pressure.
- No perfect gas exists in nature. However, hydrogen, oxygen, nitrogen and air behave as an ideal gas under normal conditions.

1.2.2. Laws of perfect gases :

The perfect gases are governed by the following laws.

1. Boyle's law
2. Charle's law
3. Joule's law
4. Avagadro's law

(a) Boyle's law: Boyle's law states that, when a gas is heated or cooled at constant temperature, the volume of the given mass of gas is inversely proportional to the absolute pressure.

$$V \propto \frac{1}{p}$$

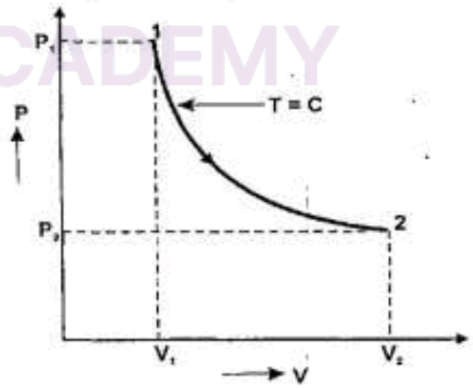


Fig. 1.11

or, $p \cdot V = \text{Constant}$

i.e., $p_1 V_1 = p_2 V_2 = C$

p_1 – original pressure of the gas (kN/m²)

V_1 – original volume of the gas (m³)

p_2 – Final pressure of the gas after change of state (kN/m²)

V_2 – Final volume of the gas after change of state (m³)

$T_1 = T_2 = T$ – Constant temperature of the gas (K)

(b) Charles' law: Charles' law states that, when a gas is heated constant pressure, the volume of the given mass of a gas ... proportional to its absoluto temperature.

$V \propto T$ or, $\frac{V}{T} = \text{Constant}$

$\frac{V_1}{T_1} = \frac{V_2}{T_2} = C$

Alcohol, LPG and CNG as fuel for IC engines

Alcohol

Alcohols, particularly ethanol (C2H5OH), are widely used as alternative fuels in internal combustion engines. Methanol (CH3OH) and butanol (C4H9OH) are also used but to a lesser extent.

Types of Alcohol Used as Fuel:

- **Ethanol:** It is the most commonly used alcohol in IC engines, often blended with petrol to form gasohol (typically 10-15% ethanol and 85-90% petrol).
- **Methanol:** This alcohol can be used in pure form or blended with gasoline. It is often produced from natural gas or biomass.
- **Butanol:** Used less frequently but can be considered a potential fuel due to its better energy density compared to ethanol.

Properties of Alcohol as Fuel:

- **High Octane Rating:** Alcohols generally have high octane numbers, which reduce knocking and allow for higher compression ratios in the engine. This leads to better fuel efficiency and performance.
- **Lower Energy Content:** Alcohols, particularly ethanol and methanol, have lower energy content compared to petrol. This means more alcohol is required to produce the same energy as a given amount of petrol.
- **Renewability:** Alcohols like ethanol are renewable because they can be produced from agricultural crops such as corn, sugarcane, and barley.
- **Oxygen Content:** Alcohol fuels contain oxygen in their chemical structure, which promotes more complete combustion and reduces harmful emissions like carbon monoxide (CO) and particulate matter.

Advantages of Alcohol as Fuel:

- **Environmental Benefits:** Alcohols are cleaner-burning than fossil fuels, producing fewer greenhouse gases such as carbon dioxide (CO2) per unit of energy produced.
- **High Octane Number:** This allows for better engine performance, with the ability to operate at higher compression ratios without knocking.
- **Renewability:** Ethanol, for example, is produced from renewable biomass sources like sugarcane and corn, making it a sustainable alternative to fossil fuels.
- **Reduction in Emissions:** Alcohol fuels result in lower emissions of CO and particulate matter, improving air quality and reducing pollution.

Disadvantages of Alcohol as Fuel:

- **Lower Energy Density:** Alcohol fuels have less energy per liter compared to petro… can result in reduced vehicle range or the need for larger fuel tanks.
- **Corrosive Nature:** Alcohols are more corrosive to engine parts, particularly those made of aluminum, rubber, and plastics.
- **Cost:** The production of alcohol fuels, especially ethanol, can be more expensive compared to petrol.
- **Compatibility Issues:** Not all existing IC engines are compatible with alcohol fuels

- High side float valve

Types of Condensers

- Air Cooled Condensers
- Water Cooled Condensers
- Evaporative Condensers

Refrigerants

Introduction:

- The thermodynamic efficiency of a refrigeration system depends mainly on its operating temperatures.
- However, important practical issues such as the system design, size, initial and operating costs, safety, reliability, and serviceability etc. depend very much on the type of refrigerant selected for a given application.
- Due to several environmental issues such as ozone layer depletion and global warming and their relation to the various refrigerants used, the selection of suitable refrigerant has become one of the most important issues in recent times.
- Replacement of an existing refrigerant by a completely new refrigerant, for whatever reason, is an expensive proposition as it may call for several changes in the design and manufacturing of refrigeration systems.
- Hence it is very important to understand the issues related to the selection and use of refrigerants. In principle, any fluid can be used as a refrigerant.
- Air used in an air cycle refrigeration system can also be considered as a refrigerant. However, in this lecture the attention is mainly focused on those fluids that can be used as refrigerants in vapour compression refrigeration systems only.

Primary and secondary refrigerants:

Fluids suitable for refrigeration purposes can be classified into primary and secondary refrigerants. Primary refrigerants are those fluids, which are used directly as working fluids, for example in vapour compression and vapour absorption refrigeration systems.

When used in compression or absorption systems, these fluids provide refrigeration by undergoing a phase change process in the evaporator. As the name implies, secondary refrigerants are those liquids, which are used for transporting thermal energy from one location to other.

Secondary refrigerants are also known under the name brines or antifreezes. Ofcourse, if the operating temperatures are above $0^{o}C$, then pure water can also be used as secondary refrigerant, for example in large air conditioning systems.

Antifreezes or brines are used when refrigeration is required at sub-zero temperatures. Unlike primary refrigerants, the secondary refrigerants do not undergo phase change as they transport energy from one location to other.

An important property of a secondary refrigerant is its freezing point. Generally, the freezing point of a brine will be lower than the freezing point of its constituents.

The temperature at which freezing of a brine takes place its depends on its concentration.

The concentration at which a lowest temperature can be reached without solidification is called as eutectic point.

The commonly used secondary refrigerants are the solutions of water and ethylene glycol, propylene glycol or calcium chloride. These solutions are known under the general name of brines.

Refrigerant selection criteria:

Selection of refrigerant for a particular application is based on the following requirements:

- Thermodynamic and thermo-physical properties
- Environmental and safety properties, and
- Economics

Thermodynamic and thermo-physical properties:

The requirements are:

a) Suction pressure: At a given evaporator temperature, the saturation pressure should be above atmospheric for prevention of air or moisture ingress into the system and ease of leak detection. Higher suction pressure is better as it leads to smaller compressor

5.2 AIR CONDITIONING

5.2.1. AIR CONDITIONING

It is defined as, "the simultaneous control of temperature humidity, purity and air motion with in an enclosed space".

5.2.2. PSYCHROMETRY

The properties of atmospheric air have to be considered more important as it affects the working of man environment as well as manufacturing goods. The atmospheric air generally consists of water vapour. The amount of water vapour plays important role in psychrometry. If it exceeds or lowers certain limit, it will create discomfort to the man. So, it is very important to keep the moisture content in the air within the specified limit in case of processing industries and air-conditioned buildings.

Psychrometry is the study and measurement of properties of air-vapour mixtures. This study is important because of its wide applications in air conditioning, cooling tower etc.

5.2.3. PSYCHROMETRIC PROPERTIES

The properties of air-vapour mixtures are known as psychrometric properties.

Dry air: The dry is nothing but the air without moisture or water vapour. The pure dry air is a mixture of number of gases such as nitrogen, oxygen, carbon dioxide, hydrogen etc.,among these except nitrogen and oxygen other gases present only in negligible quantity. So, the volumetric composition of dry air is 77% of nitrogen and 23% of oxygen.

Moist air: It is a mixture of dry air and water vapour.

Saturation capacity of air: The maximum quantity of water vapour present in air at particular air temperature is known as saturation capacity of air.

Moisture : The water vapour present in the air is known as moisture.

Dry Bulb Temperature (DBT) (t_d) : The temperature measured by an ordinary thermometer is known as dry bulb temperature.It is generally donated by t_d.

Wet Bulb Temperature (WBT) (t_w):

It is the temperature of air measured by a thermometer when its bulb is covered with wet cloth and is exposed to a current rapidly moving air. It is denoted by t_w.

Where

C_p = Specific heat at constant pressure = 1.005 kJ/kgK

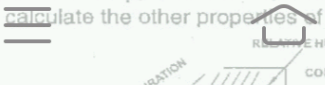
T_d = Dry bulb temperature

ω = Specific humidity

h_g = Specific enthalpy a air corresponding to dry bulb temperature.

5.2.4. Psychrometric chart

A chart which shows the interrelation between the psychro... properties is known as psychrometric chart. In a psychrometric chart, d... temperature is taken along x axis and specific humidity as ordinate to th... side of the chart as shown in figure. All other psychrometric properti... shown by different lines on the chart. The various lines are dew point temperature lines, wet bulb temperature lines, enthalpy lines, specific volume lines and relative humidity lines. If any two of these properties are known, then we can calculate the other properties of air from the chart.



01. Mechanical properties- stre...
Modified Aug 24, 2024

02. Ferrous alloys.pdf
Modified Feb 26

03. Non Ferrous Metals & Alloy...
Modified Aug 24, 2024

04. Heat Treatment - Toughen...
Modified Aug 24, 2024

05. Elastic & Plastic Deformatio...
Modified Aug 24, 2024

06. Shear force & Bending mo...
Modified Jan 2

07. Torsion.pdf
Modified Jan 2

08. Theory of simple bend
Modified Aug 24, 2024

09. Deflection.pdf

New

3.1 Introduction

A vast range of materials are available today for the choice of engineer. A proper selection of material has to be made to suit the requirements. The best material is one which serves the required objective at the minimum cost. The selection of material for a particular application involves consideration of factors like mechanical properties, service requirements, manufacturing requirements and cost of the mate[illegible]. The mechanical properties of materials are those properties which d[illegible] behaviour or the material under mechanical usage. Some mechanical properties of materials are explained below.

3.2. Mechanical properties of materials

1) Elasticity

When a body is subjected to a system of external forces, deformation of body takes place. This deformation disappears at once the external forces are removed. This property of material by which a body regains its original shape and size after deformation when applied forces are removed is known as *elasticity*.

If the body regains it original shape completely, it is said to be *perfectly elastic*. However, this phenomenon holds good up to a particular value of stress known as *elastic limit*. Beyond this limit, the deformation does not entirely disappear when the force is removed. This residual deformation is known as *permanent set*. *The elasticity property is desirable in materials used for manufacturing of tools and machine elements.*

Example: Steel and rubber are some materials having good elasticity.

2) Plasticity

Plasticity is the property of a material by which a body retains the deformation due to applied load without rupture, even after the removal of applied load. Most materials become plastic under the application of heavy forces. *Plasticity plays an important role in manufacturing processes like forming, forging, swaging, coining, extrusion, etc.*

Example: Clay and lead are some materials having good plasticity.

3) Ductility

Ductility is the property of a material by which the material can be drawn out or elongated into thin wires without rupture by applying a tensile force. A ductile material should be strong and plastic in nature. Ductility of a material is usually measured by the percentage of elongation and percentage of reduction in area at fracture. *This property is very important in manufacturing processes like rolling, wire drawing, etc.*

Example: Mild steel, copper, aluminium, zinc, gold and platinum are some materials having high ductility.

4) Malleability

Malleability is the property of a material by which the material can be flattened into thin sheets without cracking by hot or cold working processes. A malleable material possesses a high degree of plasticity and can be hammered or rolled into any desired shape without rupture. *This property is very important in manufacturing processes like forging, hot rolling, drop forging, wire drawing, etc.*

Example: Mild steel, wrought iron, copper and aluminium are some materials having high malleability.

5) Machinability

Machinability is the property of a material by which the material can be easily machined by cutting tools in various machining operations. *The machinability of different materials can be compared with the help of machinability index.*

The following are the advantages, if the material having good machinability :

1) The rate of metal removal is high
2) Long life of cutting tool
3) Less power consumption
4) Good surface finish

Example: Grey cast iron has excellent machinability.

6) Castability

Castability is the property of a material by which the material can be easily cast into different size and shapes. *Castability of a material can be decided by considering the solidification rate, shrinkage during cooling,*

constant bending moment and not due to shear force, then it is said to be in a state of *simple bending* or *pure bending*.

8.3 Theory of simple bending

Fig.8.1 Theory of simple bending

Consider a small length dx of simply supported beam subjected to bending moment M as shown in the fig.8.1(a). Due to the actic di moment, the beam as a whole will bend as shown in fig.8.1(b). di the length of the beam is changed. Let us consider a top most layer AB and bottom most layer CD. The layer AB is subjected to compression and shortened to A'B' while the layer CD is subjected to tension and stretched to C'D'.

Let us consider the beam length dx consists of large number of such layers. The length of all the layers are changed due to bending. Some of them may be shortened while some others may be stretched. However, there exists a layer EF in between the top and bottom layers which will retain its original length even after bending. This layer EF which is neither shortened nor stretched is known as the *neutral layer* or *neutral plane*.

8.4 Assumptions made in the theory of simple bending

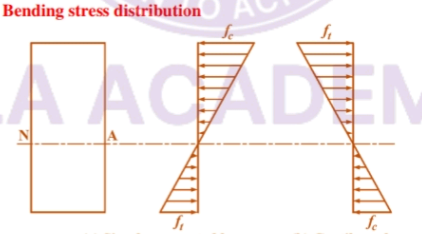
The following are the assumptions made in the theory of simple bending.

1) The material of the beam is uniform throughout.
2) The material of the beam has equal elastic properties in all directions.
3) The beam material is stressed within elastic limit and thus obeys Hooke's law.
4) The beam material has same value of Young's modulus both in tension and compression.
5) The radius of curvature of the beam is very large when compared with the cross sectional dimensions of the beam.
6) The resultant pull or push on a transverse section of the beam is zero.
7) Each layer of the beam is free to expand or contract independently of the layer, above or below it.
8) The cross section of the beam which is plane and normal before bending will remain plane and normal even after bending.

8.5 Neutral axis

The line of intersection of the neutral layer with any normal cross–section of the beam is known as *neutral axis* of that section. It is denoted as N.A. A beam is subjected to compressive stresses on one side of the neutral axis and tensile stresses on the other side of the neutral axis. There is no stress of any kind at the neutral axis.

8.6 Bending stress distribution



(a) Simply supported beam (b) Cantilever beam

Fig.8.2 Bending stress distribution

There is no stress at the neutral axis. The magnitude of stress at a point is directly proportional to its distance from the neutral axis. The maximum stress taken place at the outer most layer.

In a simply supported beam, compressive stresses are developed above the neutral axis and tensile stresses are developed below the neutral

Name

- 01. Foundary & Patterns.pdf
  Modified Jan 2
- 02. Special Casting Techniques...
  Modified Jan 2
- 03. Welding.pdf
  Modified Jan 2
- 04. Hot & Cold Working.pdf
  Modified Jan 2
- 05. Drawing,Rolling & Forging.p...
  Modified Jan 2
- 06. Powder Metallurgy.pdf
  Modified Jan 2
- 07. Processing of Plastics.pdf
  Modified Jan 2
- 08. Lathe Work.pdf
  Modified Jan 2
- 09. Planner.pdf
  Modified Jan 2
- 10. Shaper.pdf
  Modified Jan 2

Modified Jan 2

11. Slotter.pdf
Modified Jan 2

12. Drilling machines.pdf
Modified Jan 2

13. Milling machice.pdf
Modified Jan 2

14. Grinding Machines.pdf
Modified Jan 2

15. Broaching.pdf
Modified Jan 2

16. Boring & Jig Boring.pdf
Modified Jan 2

17. Gears manufacturing practi...
Modified Jan 2

18. Metal finishing.pdf
Modified Feb 26

19. Press Work.pdf
Modified Jan 2

20. Non Conventional Producto...
Modified Jan 2

21. Semi Automats.pdf
Modified Jan 2

01. Engineering Materials & Typ...
Modified Jan 8

02. Factors affecting selection ...
Modified Feb 26

03. Stresses-Tension, Compres...
Modified Feb 26

04. Couplings-types-requirem...
Modified Feb 26

05. Design of Joints.pdf
Modified Jan 8

06. Design of Fastners.pdf
Modified Jan 8

07. Design of Shaft, key & Coup...
Modified Jan 8

08. Design of Bearing(EM).pdf....
Modified Feb 26

New

08. Design of Bearing(TM...
Modified Jan 8

Engineering Materials & Types

- In the design and manufacturing of machine elements, the choice of material is crucial as it determines the strength, durability, weight, cost, and overall performance of a machine or component.
- Engineering materials are those materials which are used in the construction of mechanical components and structures.
- These materials must possess the necessary properties such as strength, hardness, toughness, fatigue resistance, and machin function efficiently under specific loading and envir conditions.

2. Types of Engineering Materials

- Engineering materials can be classified into three broad categories based on their composition and properties:
  1. Metals
  2. Polymers (Plastics)
  3. Composites
  4. Ceramics

3. Metals

- Metals are the most commonly used materials in mechanical engineering due to their excellent mechanical properties like strength, durability, and ductility.
- Metals are primarily classified into two groups: ferrous and non-ferrous metals.

3.1 Ferrous Metals

- Ferrous metals are metals that contain iron as their primary component.
- They are widely used in machine elements due to their strength and availability.

Types of Ferrous Metals:

Carbon Steel	Alloy Steel	Cast Iron
Composed mainly of iron and carbon, it is used in the manufacture of structural components, shafts, gears, etc. Formula for Carbon Content: C (carbon content) = 0.04% to 2.1%	Steel that is alloyed with other elements (such as chromium, nickel, molybdenum) to improve its properties.	Contains 2-4% carbon and is used for making heavy machine components like engine blocks, gearboxes, and housing.
Properties: High strength, easy to machine, but prone to corrosion.	Properties: Better corrosion resistance, higher strength, and toughness.	Properties: Good castability, high wear resistance, but low tensile strength.

❖ ***Steel:*** Made primarily of iron and carbon, steel has varying levels of carbon content, which determine its properties.

Low-carbon steel	Medium-carbon steel	High-carbon steel
0.05% to 0.3% carbon	0.3% to 0.6% carbon	0.6% to 1.4% carbon
Used for general-purpose applications.	Offers a balance of strength and ductility, used for shafts, gears, etc.	Used for making cutting tools, springs, and high-strength wires.

❖ ***Cast Iron:*** Cast iron contains a higher percentage of carbon (2-4%), making it more brittle but useful for applications requiring good castability and wear resistance.

Gray Cast Iron	White Cast Iron
Used in engine blocks and machinery parts.	Harder and more brittle, used for wear-resistant parts.

Factors affecting selection of materials,

Preferred number, Factor of safety and allowable stress

Factors Affecting Selection of Materials

The selection of materials for machine elements depends on a variety of factors, such as mechanical properties, thermal properties, environmental factors, manufacturing processes, and economic considerations. These factors must be evaluated carefully to ensure that the chosen material will meet the required performance criteria.

1. Mechanical Properties of Materials

Mechanical properties are critical in determining how well a material can withstand various loads and stresses during its operation. Key mechanical properties include:

a. Strength:

- Strength refers to the ability of a material to resist deformation and failure under applied loads. It includes:
  - **Tensile Strength (σ_t):** The maximum stress a material can withstand when being stretched or pulled before breaking.
  - **Compressive Strength (σ_c):** The maximum stress a material can withstand under compression.
  - **Shear Strength (τ):** The maximum stress a material can withstand under shear forces.

Formula for Tensile Strength:

$\sigma_t = F/A$

Where:

- F = Load applied (in N)

- A = Cross-sectional area of the material (in m^2)

b. Hardness:

Hardness is the ability of a material to resist surface indentation, scratching, and wear. Materials with high hardness are used for cutting tools, wear-resistant components, and other applications that require resistance to surface wear.

Common hardness scales include:

- ✓ Brinell Hardness
- ✓ Rockwell Hardness
- ✓ Vickers Hardness

c. Ductility and Toughness:

Ductility: Ductility is the ability of a material to undergo significant plastic deformation before fracture. Materials with high ductility are preferred for components that undergo large deformation without failure (e.g., in bending or stretching).

Formula for Ductility (Percent Elongation):

Percent Elongation = $L_f - L_0/L_0 \times 100$

Where:

- L_f = Final length after stretching

- L_0 = Original length

Toughness: Toughness refers to a material's ability to absorb energy and deform plastically without fracturing. It is important for materials used in impact and fatigue-prone applications.

Welded Joints

- Welding is a process of joining two similar metal by heating with or without applicat pressure and filler materials.
- Welded joint can be used an alternatively to riveted joint.

Advantages

1) The welded structure are usually lighter than riveted structure because in welding, gussets and other connecting component are not used.
2) Weld joint provide maximum efficiency which is not possible by riveted joint.
3) Alteration and addition can be easily made in the exiting structure.
4) It is smooth in appearance therefore looks pleasing.
5) In welded connection, the tension member are not weakened as in case of riveted joint.

6) A weld joint has greater strength often a welded joint has the strength of the parent metal itself.
7) Circular shape member are difficult to rivet but they can easily welded.
8) The welding provide very rigid joints
9) Welding is possible at any point, any place.
10) Welding required less time than the riveting.

Chapter 3

Design of Shaft, Keys, Couplings and Gears

3.1 Introduction

1.Shaft

- A shaft is a rotating machine element which is used to transmit power from one place to another.
- The power is delivered to the shaft by some tangential force and the resultant torque (or twisting moment) set up within the shaft permits the power to be transferred to various machines linked up to the shaft.
- In order to transfer the power from one shaft to another, the various members such as pulleys, gears etc., are mounted on it.
- These members along with the forces exerted upon them causes the shaft to bending.
- In other words, we may say that a shaft is used for the transmission of torque and bending moment.
- The -various members are mounted on the shaft by means of keys or splines.
- The shafts are usually cylindrical, but may be square or cross-shaped in section. They are solid in cross-section but sometimes hollow shafts are also used.

2. Axle

- An axle though similar in shape to the shaft, is a stationary machine element and is used for the transmission of bending moment only.
- It simply acts as a support for some rotating body such as hoisting drum, a car wheel or a rope sheave.

3. Spindle

- A spindle a short shaft that imparts motion either to a cutting tool (e.g., drill press spindles) or work piece (e.g., lathe spindles).

3.2 Material Used for Shafts

- The material used for ordinary shafts is carbon steel of grades 40 C 8 , 45 C 8, 50 C 4, 50 C12.
- When a shaft of high strength is required, then an alloy steel such as nickel, nickel-chromium or chrome-vanadium steel is used.

3.3 Properties of material used for shafts

1. It should have high strength.
2. It should have good machinability.
3. It should have low notch sensitivity factor.
4. It should have good heat treatment properties.
5. It should have high wear resistant properties.

3.4 Types of Shafts

The following two types of shafts are important from the subject point of view:

1. Transmission shafts.

- These shafts transmit power between the source and the machines absorbing power.
- The counter shafts, line shafts, over head shafts and all factory shafts are transmission shafts.
- Since these shafts carry machine parts such as pulleys, gears etc., therefore they are

Objectives

After studying this unit, you should be able to

- understand power transmission derives,
- understand law of belting,
- determine power transmitted by belt drive and gear,
- determine dimensions of belt for given power to be transmitted,
- understand kinematics of chain drive,
- determine gear ratio for different type of gear trains,
- classify gears, and
- understand gear terminology.

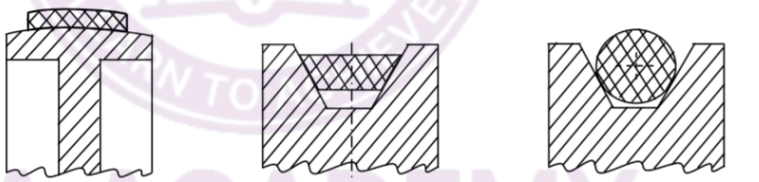
3.2 POWER TRANSMISSION DEVICES

Power transmission devices are very commonly used to transmit power from one shaft to another. Belts, chains and gears are used for this purpose. When the distance between the shafts is large, belts or ropes are used and for intermediate distance chains can be used. For belt drive distance can be maximum but this should not be more than ten metres for good results. Gear drive is used for short distances.

3.2.1 Belts

In case of belts, friction between the belt and pulley is used to transmit power. In practice, there is always some amount of slip between belt and pulleys, therefore, exact velocity ratio cannot be obtained. That is why, belt drive is not a positive drive. Therefore, the belt drive is used where exact velocity ratio is not required.

The following types of belts shown in Figure 3.1 are most commonly used :



(a) Flat Belt and Pulley **(b) V-belt and Pulley** **(c) Circular Belt or Rope Pulley**

Figure 3.1 : Types of Belt and Pulley

The flat belt is rectangular in cross-section as shown in Figure 3.1(a). The pulley for this belt is slightly crowned to prevent slip of the belt to one side. It utilises the friction between the flat surface of the belt and pulley.

The V-belt is trapezoidal in section as shown in Figure 3.1(b). It utilizes the force of friction between the inclined sides of the belt and pulley. They are preferred when distance is comparative shorter. Several V-belts can also be used together if power transmitted is more.

The circular belt or rope is circular in section as shown in Figure 8.1(c). Several ropes also can be used together to transmit more power.

The belt drives are of the following types :

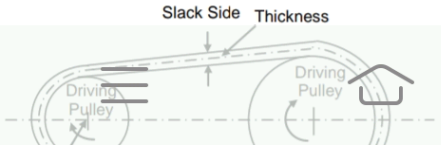
(a) open belt drive, and

(b) cross belt drive.

Open Belt Drive

Open belt drive is used when sense of rotation of both the pulleys is same. It is desirable to keep the tight side of the belt on the lower side and slack side at the

op to increase the angle of contact on the pulleys. This type of drive is shown in
igure 3.2.



Name

- 01. CAD-Definition.pdf
  Modified Jan 8
- 02. Geometric Modeling-Wirefr...
  Modified Jan 8
- 03. Graphic standards-GKS, IG...
  Modified Jan 8
- 04. CAM- Definition.pdf
  Modified Jan 8
- 05. Group Technology– Part fa...
  Modified Jan 8
- 06. CAPP & Types.pdf
  Modified Jan 8
- 07. CNC-Definition.pdf
  Modified Jan 8
- 08. CNC Components(EM).pdf
  Modified Jan 8
- 08. Components of CNC-(TM)....
  Modified Jan 8
- 09. Part Program-(EM).pdf
  Modified Jan 8

PDF 10. Part program format coordi...
Modified Jan 8

PDF 11. Types of Motion Control-(E...
Modified Feb 26

PDF 11. Types of Motion Control-(T...
Modified Jan 8

PDF 12. Types of Interpolation.pdf
Modified Jan 8

PDF 13. G & M Codes.pdf
Modified Jan 8

PDF 14. Sub program & Canned Cycl...
Modified Jan 8

PDF 15. FMS.pdf
Modified Jan 8

PDF 16. AGV.pdf
Modified Jan 8

PDF 17. Robotics.pdf
Modified Jan 8

New

UNIT – I
COMPUTER AIDED DESIGN

1.1.0. Introduction

Computer Aided Design (CAD) is the technology concerned with the integrated design activities using a digital computer. This includes creation and modification of graphic images on a display, printing these images on a printer or plotter as a hard copy, analyzing and optimizing the design and storing and retrieving of design information for further process as database.

CAD can be described as any design activity that involves the effective use of computer to create and modify an engineering design. The use of a computer in the design of a product is to increase the productivity of the designer and to create a database for manufact

1.1.1. CAD definition

CAD is the term which means Computer Aided Design. CAD can be defined that the computer is utilized in the creation of model, modification and analysis of a design to get the optimum model.

1.1.2. Design process

The design process is the pattern of activities followed by the designer in arriving at the solution of a technological problem generated. The design progresses are a step-by-step manner from identification of the problem to give the better solution for the problem.

There are different models available in the design process. They are Shigley, Pahl and Beitz, Ohsuga and Earle.

1.1.3. Shigley's Design process

The six steps involved in the Shigley model is shown in the flow chart and explained below.

Recognition of need

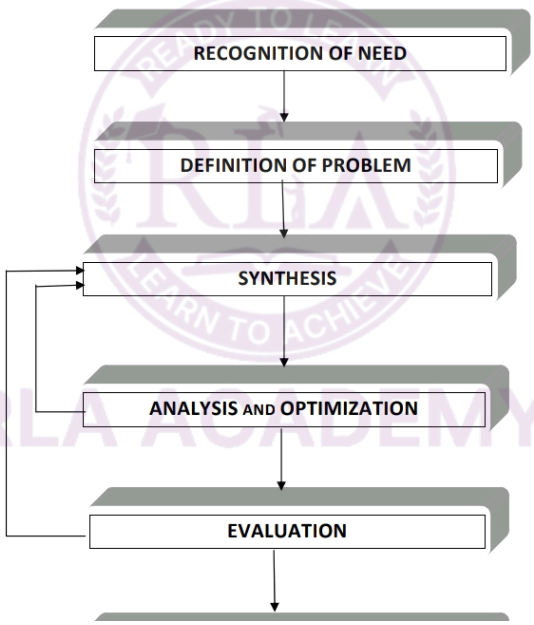
Recognition of need involves the realization of a problem exists for which some feasible solution has to be found. This might be the identification of some defect in a current machine designed by an engineer or the perception of a new product marketing opportunity by a salesman.

Definition of a problem

Definition of a problem involves a thorough specification of the item to be designed. This specification will generally include functional and physical characteristics, cost, quality, performance, etc.

Synthesis

During the synthesis phase of the design process, various preliminary ideas are developed through research of similar products or designs in use.



1.4.1. Graphic standards

A large number of applications are used in CAD/CAM, which are manufactured by different vendors. Therefore, there is a need to establish standards in CAD that help in linking different hardware and software systems from different vendors. In addition, the data from a CAD system is to be transferred to the CAM system to achieve Computer Integrated Manufacturing (CIM). The standards used in CAD for exchanging data are called graphics standards.

1.4.2. Need or benefits of graphics standards

Graphics standards are needed to achieve the following benefits in CAD.

Application program portability: The program in a CAD system should not be hardware dependent. It is desired to have programs, which are interchangeable with a number of systems.

Picture data portability: Description and storage of picture should be independent of different graphic devices.

Text portability: Representation of text associated with the graphics should be independent of hardware.

Object database portability: In CAD, analysis and manufacturing operations should be integrated for sharing design database.

The following are the common graphics standards used in CAD/CAM applications.

- GKS (Graphical Kernel System)
- PHIGS (Programmer's Hierarchical Interface for Graphics)
- IGES (Initial Graphics Exchange Specification)
- DXF (Drawing Exchange Format)
- STEP (STandard for the Exchange of Product model data)
- DMIS (Dimensional Measurement Interface Specifications)
- VOI (Virtual Device InterfaceD
- VDM (Virtual Device Met3file)
- GKSM (GKS'Metafile)
- NAPLPS (North American Presentation Level Protocol Syntax)
- WMF (Windows Meta File)

1.4.3. Graphic Kernel System (GKS)

GKS is essentially a set of procedures that can be called by user programs for carrying out certain generalized functions. Taking all the existing graphic packages, ISO has standardized the GKS as a 2D standard.

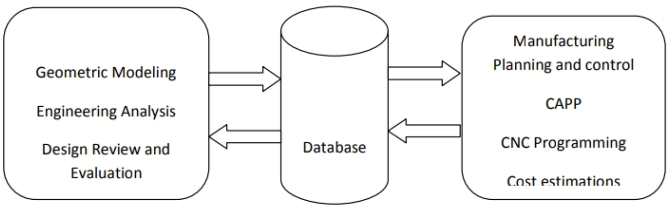


Figure 4.4 Integrated CAD/CAM

4.2.1 Flexible Manufacturing Systems (FMS)

Introduction

FMS is an integrated approach to automate the production in industries. The competition in the global market has compelled the manufacturers to reduce delivery times and to quote competitive prices even for relatively small orders. To meet specific customer requirements considerable flexibility in the manufacturing system is to be required for small batch sizes too. Flexible manufacturing cells and flexible manufacturing systems have been evolved to meet the requirements.

Definition

FMS is a computer controlled manufacturing system integrates the automated production machines and material handling equipments. The FMS is designed to be flexible so that it can fabricate a variety of different products of relatively low volumes.

4.2.2 FMS components

The major components of the FMS are

- Computer controlled manufacturing equipments
- Automated material storage, transport and transfer system
- Computer control system
- Human labour

Computer controlled manufacturing equipments: This is otherwise called as workstations or processing stations. The major work stations are CNC machine tools for machining operations. The other types of processing equipments including inspection stations, assembly stations and sheet metal stations are also under this component.

Automated material storage, transport and transfer system: Various types of automated material handling equipments are used to transport the work parts and subassemblies between the processing stations. Some times it includes automatic storage and retrieval system also.

Computer control system: Computers are used to control and coordinate the activities of the various processing stations and the material handling system in the FMS.

Human labour: Human beings are required for the following operations of FMS

1. Loading of raw materials into the system
2. Unloading of finished components from the system
3. Changing and setting tools.
4. Maintenance of equipments.
5. Programming the workstations.
6. Controlling the whole operations.

Manufacturing equipments

It is the first major component of the FMS. It includes the following type of machines

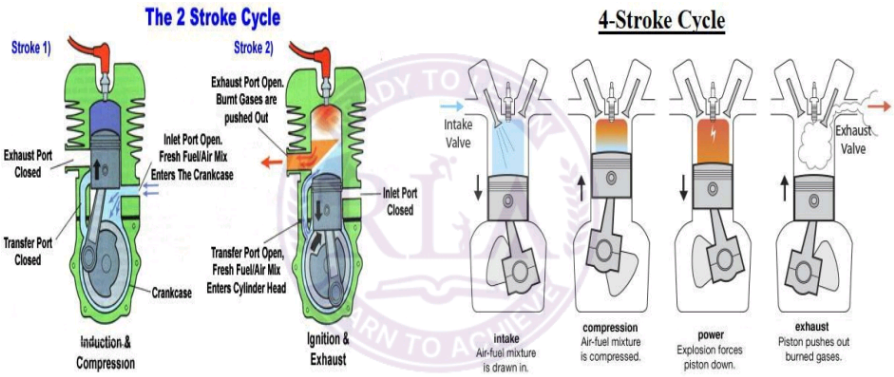
- Machining centers
- Turning centers
- Head changers
- Head indexers

Name

- 01. IC Engines.pdf
  Modified Feb 26
- 02. Principles of 2 stroke and 4 ...
  Modified Feb 26
- 03. Engines Valve Timing-Port ...
  Modified Aug 24, 2024
- 04. OHV and OHC.pdf
  Modified Feb 26
- 05. Engine blocks-Cylinder Hea...
  Modified Aug 24, 2024
- 06. Camshaft.pdf
  Modified Aug 24, 2024
- 07. Timing gears.pdf
  Modified Feb 26
- 08. Firing order.pdf
  Modified Feb 26
- 09. Carburation.pdf
  Modified Feb 26
- 10. MPFI.pdf
  Modified Aug 24, 2024
- 11. Combustion process of Dies...
  Modified Aug 24, 2024

- 13. CRDI.pdf
  Modified Aug 24, 2024
- 14. Injectors types.pdf
  Modified Aug 24, 2024
- 15. Cooling system & Radiatos....
  Modified Aug 24, 2024
- 15. Radiator.pdf
  Modified Feb 26
- 16. Expansion reservoir cooling ...
  Modified Feb 27
- 17. Coolant types.pdf
  Modified Feb 27
- 18. Lubricating system - Full pr...
  Modified Aug 24, 2024
- 19. Turbochargers & Pollutants....
  Modified Feb 27
- 17. Coolant types.pdf
  Modified Feb 27
- 18. Lubricating system - Full pr...
  Modified Aug 24, 2024
- 19. Turbochargers & Pollutants....
  Modified Feb 27
- 20. Emission control systems in...

Working principle of two stroke and four stroke cycle



2-Stroke cycle; Two stroke cycle perform only two strokes to complete one cycle. The power is obtained only once in one revolution of the crankshaft. 2-Stroke cycle used in two types of engines mentioned below.

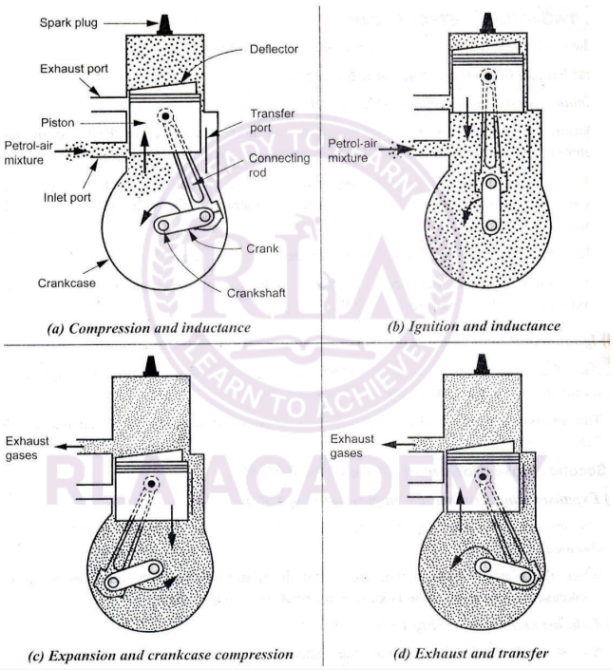
1. 2-Stroke Petrol engine
2. 2-Stroke Diesel engine

4-Stroke cycle; four stroke cycle perform only four strokes to complete one cycle. The power is obtained only once in two revolutions of the crankshaft. 4-Stroke cycle used in two types of engines mentioned below.

1. 4-Stroke Petrol engine
2. 4-Stroke Diesel engine

8

2-Stroke Petrol (S.I) engine



9

First Stroke (Upward Stroke of the Piston) of 2-Stroke Petrol engine

(a) Compression and Inductance:
During the upward movement of the piston from BDC to TDC, both the transfer and exhaust ports are covered by the piston.The petrol air mixture which is already transferred into the engine cylinder is compressed by the moving piston. Thus, the pressure and temperature of the charge increases at the end of co compression process is continued until the piston reaches TDC.At the same time, the inlet port i the moving piston and the fresh petrol air mixture enters the crankcase through the inlet port.

(b) Ignition and Inductance:
After the piston almost reaches the TDC, the compressed petrol air mixture is ignited by mean spark produced by a spark plug.
The admission of fresh charge into the crankcase continues till the piston reaches the TDC.

Second Stroke (Downward Stroke of the Piston) of 2-Stroke Petrol engine

(c) Expansion and Crankcase Compression:
The ignited gases expand and forces the piston to move down, thus useful work is obtained.
When the piston moves down, the petrol air mixture is partially compressed in the crankcase. Thus

Emission Control Systems in SI and CI Engines:

EGR, Catalytic Converter, PCV, DPF, and SCR

Automobile engines, both Spark Ignition (SI) and Compression Ignition (CI), produce various pollutants as by-products of combustion, including hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (PM). These pollutants contribute to air pollution and health issues. To mitigate these harmful emissions and adhere to environmental regulations, advanced emission control systems have been developed.

This document focuses on key emission control systems used in SI and CI engines:

1. Exhaust Gas Recirculation (EGR)

2. Catalytic Converter

3. Positive Crankcase Ventilation (PCV)

4. Diesel Particulate Filter (DPF)

5. Selective Catalytic Reduction (SCR)

1. Exhaust Gas Recirculation (EGR)

Function:

- Exhaust Gas Recirculation (EGR) is a method used to reduce NOx emissions in both SI and CI engines. By recirculating a portion of the engine's exhaust gases back into the intake air, the system lowers the combustion temperature, thus reducing the formation of NOx, which is primarily created at high temperatures.

How it Works:

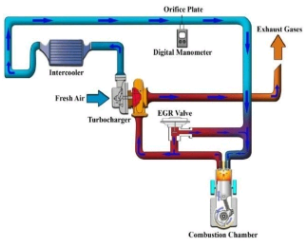
- **In SI Engines:** EGR works by recirculating a controlled amount of exhaust gases back into the intake manifold. This reduces the peak combustion temperature by lowering the oxygen concentration during combustion, leading to reduced NOx formation.
- **In CI Engines:** Similar to SI engines, but since diesel engines operate at higher temperatures and pressures, EGR helps to control NOx emissions by lowering the combustion temperature.

Advantages:

- ✓ Reduces NOx emissions.
- ✓ Improves fuel efficiency by lowering combustion temperatures.
- ✓ Works in both SI and CI engines.

Disadvantages:

- ✓ May increase soot production, particularly in CI engines.
- ✓ Can cause carbon buildup in the intake manifold over time.
- ✓ May reduce engine performance due to lower combustion temperatures.



2. Catalytic Converter

Function:

- A catalytic converter is a device used in the exhaust system to reduce harmful emissions from both SI and CI engines. It converts toxic gases such as carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NOx) into less harmful emissions such as nitrogen (N2), carbon dioxide (CO2), and water (H2O) through chemical reactions.

How it Works:

- The catalytic converter contains a substrate (usually ceramic or metal) coated with pr metals like platinum, palladium, and rhodium, which act as catalysts.
- The three-way catalyst system used in modern catalytic converters performs the follo reactions:
  - ✓ $CO + O2 \rightarrow CO2$ (Converts carbon monoxide into carbon dioxide)
  - ✓ $HC + O2 \rightarrow CO2 + H2O$ (Converts hydrocarbons into carbon dioxide and water)
  - ✓ $NOx \rightarrow N2 + O2$ (Reduces nitrogen oxides into nitrogen and oxygen)

Advantages:

- ✓ Significant reduction in CO, HC, and NOx emissions.

- 01. Friction and Transmission o...
  Modified Feb 28
- 02. Clutches.pdf
  Modified Aug 24, 2024
- 03. Gear boxes.pdf
  Modified Aug 24, 2024
- 04. Manual and Automatic.pdf
  Modified Feb 28
- 05. Universal Joints-Constant v...
  Modified Aug 24, 2024
- 06. Axle-Live and Dead Axles.p...
  Modified Mar 2
- 06. Floating Axle.pdf
  Modified Aug 24, 2024
- 07. Diffferential.pdf
  Modified Aug 24, 2024
- 08. Suspension System – Front ...

09. Leaf spring and Tandem axl...
Modified Mar 2

10. Air suspension.pdf
Modified Mar 2

11. Steering-Wheel Alignment–...
Modified Aug 24, 2024

12. Brakes – Braking efficiency....
Modified Aug 24, 2024

13. Air brake system & Anti-lock...
Modified Mar 2

14. Hydraulic retarders.pdf
Modified Mar 2

15. Tyres - Tubes - types – Tyre...
Modified Aug 24, 2024

16. Preventive Maintenance and...
Modified Mar 2

New

Friction and Transmission of motion

1. Friction in Transmission Systems

- Friction plays a significant role in transmission systems as it helps to transmit power and motion between parts. However, excessive friction can lead to power loss, wear, and increased fuel consumption. In transmission systems, friction is intentionally utilized in certain areas to facilitate the transfer of power and motion, while it must be minimized in others to reduce losses and improve efficiency.

Types of Friction in Transmission Systems:

1. Static Friction:

- Static friction is the force that prevents two surfaces from sliding past each other. This type of friction exists when two parts are at rest and resist the initial motion. In transmission systems, static friction is crucial in parts like the clutch and brake systems where parts must remain in place until force is applied to cause movement.

2. Kinetic (Dynamic) Friction:

- Kinetic friction occurs when two surfaces are in motion relative to each other. In transmission systems, this type of friction is seen in gears, bearings, and sliding parts. While it helps transfer energy, it also causes wear and energy loss. Designers aim to minimize kinetic friction through lubrication and material selection.

3. Rolling Friction:

- Rolling friction is the resistance encountered when an object rolls over a surface. In automobile transmission systems, rolling friction is encountered in components like wheels, bearings, and rollers. Although it is generally lower than sliding friction, it still contributes to energy losses and needs to be optimized.

Friction in Key Transmission Components:

1. Clutch:

- The clutch is a device that uses friction to engage or disengage the engine from the transmission. The clutch consists of a flywheel, pressure plate, and clutch disc. The friction between the clutch disc and flywheel transfers power from the engine to the transmission.
- Excessive friction leads to wear, slippage, and overheating, while insufficient friction results in poor power transmission.

2. Brakes:

- Braking systems rely on friction between the brake pads and the rotating brake disc or drum to slow down the vehicle. The amount of friction generated directly impacts the braking efficiency.

3. Gearbox:

- In a manual transmission, gears mesh with each other, and the friction between gears enables the transfer of motion. The type of material and the lubrication u gears play a crucial role in controlling friction and ensuring smooth operation.

4. Bearings:

- Bearings in the transmission system, such as ball bearings and roller bearings, minimize friction between rotating parts. These bearings reduce wear and improve the efficiency of the transmission.

CLUTCH

2.1 Introduction

Clutch is a device used in the transmission system of an automobile to engage and disengage the engine to the gear box. Thus the clutch is fitted in between the engine and the gear box. The engaging and disengaging of the engine from the gear box should be smooth and gradually (progressive). The clutch works on the principle of "Friction"

In engaged position, the power is transmitted to the driving wheels through the transmission system. In disengaged position, the power is not transmitted to the driving wheels and the vehicle stops but the engine still runs. During normal running and stationary position clutch is always is engaged condition. When the driver presses the clutch pedal, It provides grip to the engine the gear box the clutch is disengaged..

2.2 Function

i) It is used for connecting or disconnecting the drive of the engine to the gear box.

ii) Clutch is used to transmit the power of from engine to gear box.

iii) To disconnect the engine power from the gear box as required under following situation.

- To start the engine and warm it up.
- To facilitate engaging the first or second gear to move the vehicle from rest.
- To change the gear easily without noise.
- To stopping the vehicle and idling the engine
- It helps to transmit the engine cranking to the transmission system without any vibration.

2.3 Requirement of clutch

1. **Torque transmission :** The clutch should be able to transmit maximum torque to the gear box.
2. **Gradual engagement :** The clutch should engage gradually to avoid sudden jerks.
3. **Heat dissipation :** The clutch should be able to dissipate large amount of heat which is generated during the clutch op due to friction.
4. **Dynamic balancing :** The clutch should be dyna balanced. This is particularly required in the case of high engine clutches.
5. **Vibration damping :** The clutch should have suitable mechanism to damp vibrations and to eliminate noise produced during power transmission.

BRAKES

5.1 Introduction

- Brake is the most important component of an automobile.
- The vehicle is started, accelerated and it runs on the road. But stopping of the vehicle is an essential thing. The mechanism which is used to slow and stop the vehicle using frictional force is known as braking system.
- Brakes are mechanical devices used to stop the vehicle with in the shortest possible distance.
- Brake is a device which is used to stop the rotating wheel by friction due to rubbing action using brake shoe and friction pads etc., in an Automobile.

Principle

When the brakes are applied on a moving vehicle the kinetic energy of the vehicle is transformed into heat, generated by the friction between two making surface of brake lining and brake drum. Then the heat is dissipated into the atmosphere.

The force of friction between the linings and the drums depends upon the co-efficient of friction of the two materials, force applied between the sliding surface, the roughness of the surface, and the surface material.

5.2. Purpose of Brakes

- To stop the vehicle quickly within the shortest possible distance.
- To slow down or stop the motion of a moving vehicle.
- To park the vehicle.
- To control the speed of the vehicle.

5.2.1 Requirements of a good braking system

- The brakes are used stop the vehicle in shortest possible distance and time.
- The brakes should work equally good on bad roads.
- Pedal effort applied by the driver should not be more.
- Brakes should work equally good in all weather.
- It should have less wearing parts.
- It should require little maintenance.
- Brakes when applied should not disturb steering geometry.
- When brakes are applied, the vehicle should not pull to one side.
- It should produce less noise and vibration while applying brake.
- It should have less weight and high reliability.
- Wheel should not be skidding while applying brakes.

Preventive Maintenance and Servicing

1. Introduction

Tyres are one of the most critical components of a vehicle's chassis and transmission system. They are the primary contact points between the vehicle and the road, providing the necessary traction, stability, and control for the vehicle. Tubes, though less commonly used in modern vehicles (with the advent of tubeless tyres), still play an important role in older vehicles or certain specialized applications.

Preventive maintenance and servicing of tyres and tubes are essential to ensure the longevity, performance, and safety of the vehicle. Proper care reduces the risk of accidents due to sudden tyre failures, improves fuel efficiency, and extends the overall lifespan of the vehicle's tyres and tubes.

2. Importance of Tyre and Tube Maintenance

1. Safety: Properly maintained tyres ensure optimal traction, reducing the risk of skidding, blowouts, or accidents, especially under adverse road conditions.

2. Performance: Correct tyre pressure and tread depth enhance the vehicle's performance, improving handling, braking, and overall driving comfort.

3. Fuel Efficiency: Worn-out tyres or those under-inflated increase rolling resistance, which leads to higher fuel consumption.

4. Cost Savings: Regular maintenance helps extend the life of the tyres, reducing the frequency of costly replacements.

3. Key Aspects of Tyre and Tube Preventive Maintenance

Effective tyre and tube maintenance involves periodic checks and corrective measures to ensure that they function optimally throughout their life. Key aspects include:

1. Tyre Pressure Monitoring

- Maintaining the correct air pressure is the most important aspect of tyre maintenance. Under-inflated tyres cause excess wear, poor fuel efficiency, and overheating. Over-inflated tyres lead to reduced contact area with the road, decreasing traction.
- Recommended Pressure: Each vehicle has a manufacturer-recommended tyre pressure (measured in PSI). It can be found in the owner's manual or on a placard inside the driver's door.
- Preventive Measure: Regularly check tyre pressure (at least once a month or before long trips) using a tire pressure gauge. Tyres should be checked when cold (before driving for more than a mile).

- **Formula for correct tyre inflation:**

  P = F/A

  Where:

  - P = Pressure (in PSI)
  - F = Force applied by the vehicle (in Newtons)
  - A = Contact area (in square inches)

2. Tyre Tread Depth Check

- The tread provides the friction and grip that helps in stopping the vehicle. Over ... the tread wears down, reducing its effectiveness, particularly in wet conditions.
- Legal Minimum Tread Depth: The minimum legal tread depth varies by country, but generally, it is around 1.6 mm. Anything lower increases the risk of aquaplaning and loss of control.
- Preventive Measure: Use a tread depth gauge or the penny test to check the tread depth. Replace tyres if they are below the legal limit.

Name

- 01. Units & Symbols.pdf
  Modified Aug 24, 2024
- 02. AC and DC.pdf
  Modified Aug 24, 2024
- 03. Ohms Law.pdf
  Modified Aug 23, 2024
- 04. Kirchoff_s Law.pdf
  Modified Aug 23, 2024
- 05. Electro Magnetism.pdf
  Modified Aug 24, 2024
- 06. EMF.pdf
  Modified Aug 24, 2024
- 07. Alternators.pdf
  Modified Aug 24, 2024
- 08. Staring Motors.pdf
  Modified Aug 24, 2024
- 09. Battery lead Acid & Types.p...
  Modified Aug 24, 2024
- 10. Capacity - Battery.pdf
  Modified Aug 24, 2024
- 11. Iginition System-coil & electr...
  Modified Aug 24, 2024

PDF 20. Battery – Li based batteries...
Modified Mar 3

PDF 21. Hybrid EV – Mild, Series, Par...
Modified Mar 3

PDF 22. Battery charging -Types - N...
Modified Mar 3

PDF 23. Battery swapping technique...
Modified Mar 3

PDF 24. Battery Management Syste...
Modified Mar 3

PDF 25. Motor – Types – Brushless ...
Modified Mar 3

PDF 26. E-vehicle policy_watermark....
Modified Mar 3

PDF 27. Fuel cell vehicle.pdf
Modified Mar 3

PDF 28. Indian Electric Vehicle
Modified Mar 3

New

1.1 AC FUNDAMENTALS

1.1.1 DIFFERENCE BETWEEN AC AND DC

AC current

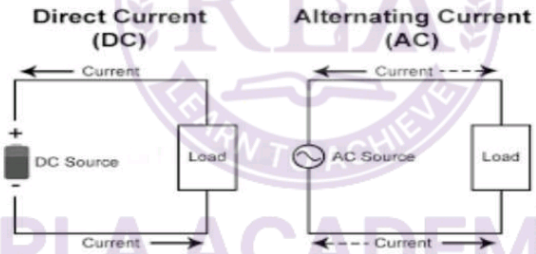
Alternating current is defined as the flow of charge that changes direction periodically. The result obtained will be, the voltage level also reverses along with the current.

A.C, current and voltages are varying in magnitude and polarity.

DC current

By D.C, we mean current and voltages have a fixed polarity and constant Magnitude.

Direct current (DC) is a flow of electrical charge carriers that always takes place in the same direction.



1.1.2

ADVANTAGES OF AC OVER DC

We all know that we got ac supply in our homes and we got this supply by transmitting ac over long distances.
Electric energy is generated and used is AC because it offers much advantages then DC. The few are listed below:-

ADVANTAGES

1. AC can be transmitted using step up transformers but direct current or dc Cannot be transmitted by this method.

2. The ac is easy to generate than dc.
3. It is cheaper to generate ac than dc.
4. The ac generators have higher efficiency than dc

Sensors & Electronic Control Unit (ECU)

In modern electrical and mechanical systems, sensors and Electronic Control Units (ECUs) are integral components used to monitor and control various processes. Sensors detect changes in the environment or in a system, while ECUs process the sensor data and control the system based on this information. These components are widely used in automotive, industrial automation, home appliances, robotics, and aerospace applications.

Sensors:

A sensor is a device that detects physical or environmental changes and converts them into electrical signals that can be measured or processed. These sensors play a crucial role in ensuring the proper operation of systems by providing real-time data to control systems like the ECU.

Electronic Control Unit (ECU):

An Electronic Control Unit (ECU) is an embedded system that manages and controls specific functions of a vehicle or machine. It takes input from various sensors, processes the data using algorithms, and then sends commands to other systems or actuators to perform a specific task. In vehicles, ECUs are crucial for tasks like controlling engine performance, emissions, braking systems, and safety features.

2. Role of Sensors in ECUs

Sensors provide real-time data that the ECU uses to make decisions about how to control systems. In an automobile, for instance, the sensors measure parameters such as temperature, pressure, speed, and position. The ECU processes this information and adjusts the system accordingly to maintain optimal performance.

Key Sensors in ECUs:

Temperature Sensors:	➢ **Type:** Thermocouples, RTDs (Resistance Temperature Detectors), thermistors. ➢ **Function:** Measure temperature changes in the engine, coolant, exhaust gases, and other critical components. ➢ **Application:** Used to monitor engine temperature to control the cooling fan, manage fuel injection timing, and ensure safe operation.

Hybrid Vehicles

HYBRID VEHICLES

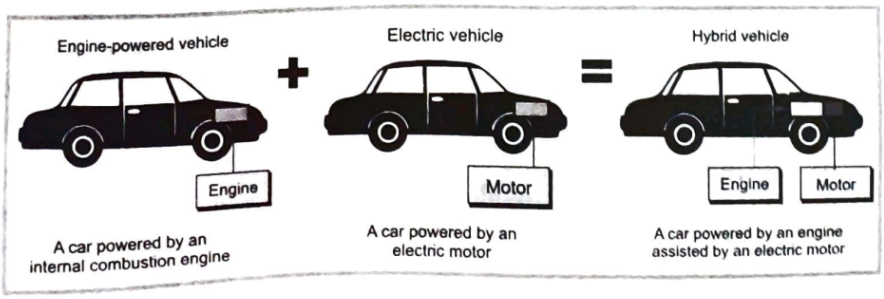
Pure electric vehicles run only on batteries and need a charger to replenish the battery's power from an electrical outlet.

A hybrid is a vehicle that has two or more power sources to propel it. An example that is often seen is a moped. The petrol engine is one power source and the rider provides the second power source by 'pedal power'. Other vehicles that are classed as hybrid include some trains (diesel and electric) and submarines (nuclear and electric).

HYBRID ELECTRIC VEHICLES (HEV)

A hybrid electric vehicle (HEV) is a type of vehicle that uses both an electric motor (s) and a conventional internal combustion engine (petrol or diesel engine). This type of vehicle is considered to have better performance (increased torque and power), fuel economy and reduced emissions compared to a conventional one of the same size, performance and comfort.

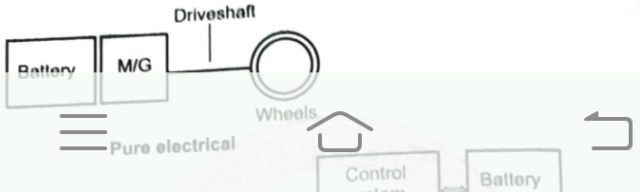
Hybrid vehicle has a small battery (shown in red color) which drives the vehicle over a short distance before switching to engine. A hybrid electric vehicle cannot be plugged in for charging. Instead, the battery is charged through regenerative braking and by the internal combustion engine.



Hybrid electric vehicles (HEVs) incorporate a small internal combustion engine with an electric motor and storage batteries. They

eliminate the basic weaknesses of electric vehicles (limited range, bulky and heavy, more time for recharge, etc) and internal combustion engines (harmful emissions, higher fuel consumption, etc).

A hybrid electric vehicle has more promise than an electric vehicle, since the HEV has an internal combustion engine to provide the energy to meet vehicle range requirements. The battery then provides additional power needed for acceleration and climbing hills. The used in the HEV engines in current production include gasoline and natural gas.



Fuel Cell Electric Vehicle (FCEV)

The feasible alternatives to batteries for electric vehicles and hybrid electric vehicles are fuel cells and flywheels.

Fuel cell

A fuel cell is an electrochemical energy conversion device. A fuel cell converts the chemicals hydrogen and oxygen into water and in the process it produces electricity (DC voltage) with water and heat as its by-product. In principle, a fuel cell operates like a battery. Unlike battery, a fuel cell does not run down or require recharging. It will produce electricity as long as fuel is supplied.

There are different types of fuel cells, each using a different chemistry. Fuel cells are usually classified by the type of electrolyte they use.

- Alkaline fuel cell
- Phosphoric fuel cell
- Solid oxide fuel cell
- Molten carbonate fuel cell

Principle

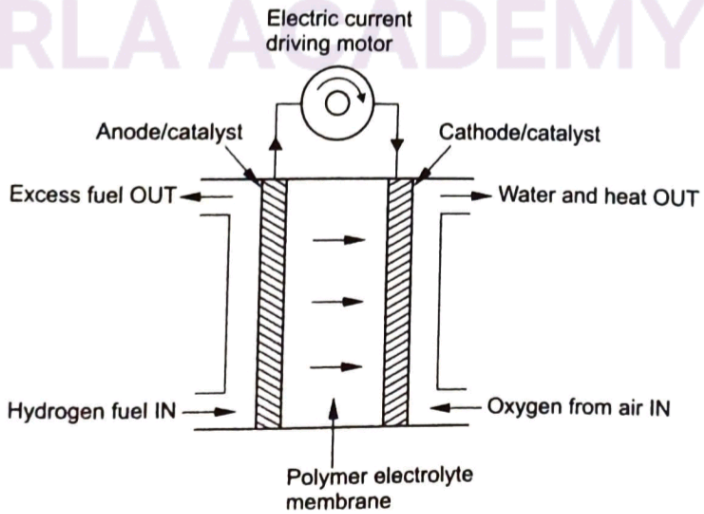


Fig.16.1: *Fuel cell*

A fuel cell consists of two electrodes sandwiched around an electrolyte. Oxygen passes over one electrode and hydrogen over the other, generating electricity, water and heat.

The pressurised hydrogen gas (H_2) entering the fuel cell flows to the anode side, which is negative post of the fuel cell. It conducts the electrons that are free from the hydrogen molecules so that they can be used in an external circuit. It has channels etched into it that disperse the hydrogen gas equally over the surface of the catalyst.

Oxygen (or air) enters through the cathode, which is the positive post of fuel cell. The cathode also has channels etched into it that

Name

- 01. Terminology.pdf
  Modified Aug 24, 2024
- 02. Classification of Motor Vehi...
  Modified Aug 24, 2024
- 03. CAR Body.pdf
  Modified Mar 3
- 03. Passenger Transport & Pas...
  Modified Aug 24, 2024
- 04. Goods Transport.pdf
  Modified Aug 24, 2024
- 04. Passnger & Goods Transpo...
  Modified Mar 3
- 05. Chasis & Frames.pdf
  Modified Aug 24, 2024
- 07. Aerodynamic body consider...
  Modified Mar 3
- 08. Safety consideration.pdf
  Modified Mar 4
- 09. Active and Passive safety s...
  Modified Mar 4

PDF 12. NVH Level.pdf
Modified Mar 4

PDF 13. Bus body construction - reg...
Modified Mar 4

PDF 14. Goods vehicle construction....
Modified Mar 4

PDF 15. Truck classifications.pdf
Modified Mar 4

PDF 16. Special vehicles.pdf
Modified Mar 5

PDF 17. Ergonomics of Driver seat d...
Modified Mar 4

PDF 18. Painitng.pdf
Modified Mar 5

PDF 19. Body repairing.pdf
Modified Mar 5

PDF 20. Maintenance and safe
Modified Mar 5

New

CAR BODY DETAILS

Importance of vehicle body engineering

1. Vehicle body contributes about 40% to 60% of total weight in the case of cars and about 65 to 70% in the case of buses. Payload is determined by body weight.
2. Reduction in body weight not only improves capacity but also fuel consumption.
3. Aerodynamic characteristics determine the fuel consumption of high speed and stability in cross wind. +ve pressure on the front and –ve pressure on the rear of the car should be minized.
4. Safety of driver, passenger and pedestrians should be considered.
5. In direct test body contributes about 50 to 70% of total cost. In indirect cost expected life influence the price.

Types of car bodies

Classification of cars:

1. four door saloon
2. Limousine
3. Convertibles
4. Estate car
5. Sports coupe

Four door saloon

This is the most common passenger car, passenger comforts such as well designed seats, ease of entry and exit, good seating and ventilation system and better styling are the features of this model Drag coefficient of this model is about 0.35 to 0.5 The features of 2 door saloon and pillar less saloon are the same as that of 4 door saloon. However is pillarless saloon there will not ba a center pillar.

Limousine

It is a luxury car. It is provided with components and equipments of high quality and with better finish. It is usually provided with a partition between the driver and the passengers. Cushioned seats, air conditioning cooling glasses etc. are the other features of this model.

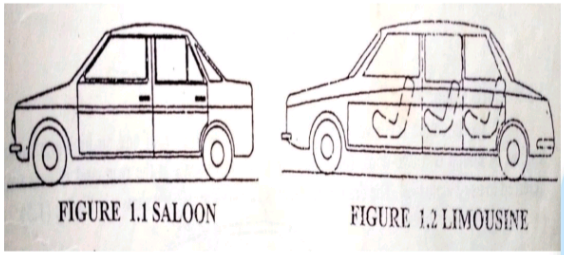


Fig:1 Saloon & limousine

Sports coupe

It is a small car with two seats better aerodynamics shape and better acceleration are the features of this model. Styling is not important. Lightness and rigidity are also the features of this model CD =0.2 to 0.3 Coupe is similar to sports coupe but with two extra seats at the back and hence can be used as a small family car.

Estate car

BUS BODY AND COMMERCIAL VEHICLE DETAILS

CLASSIFICATION OF BUSES

Passenger carrying buses are classifies based on:

1) Distance traveled by the vehicle
2) Capacity of the vehicle
3) Shape and Style of the vehicle

1**. Distance traveled by the vehicle**:

1. Mini bus 2.Town bus 3.Suburban bus 4.Long Distance Coaches 5.Touring Coaches 6.Midi bus

1. MINI BUS:

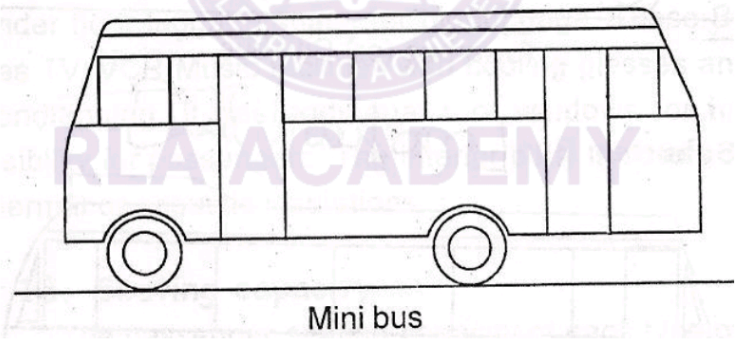


Fig:1 mini bus

Fig:2 Mini bus

- It should have a seating capacity upto 25.
- It built on light duty truck chassis.
- It has front mounted engine and rear axle drive.
- It has soft and comfort suspension.
- It has reasonably comfortable seat.
- It has fairly small entry platforms.

2. Town bus

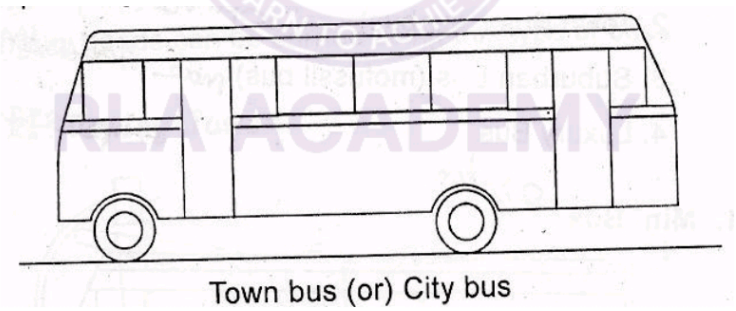
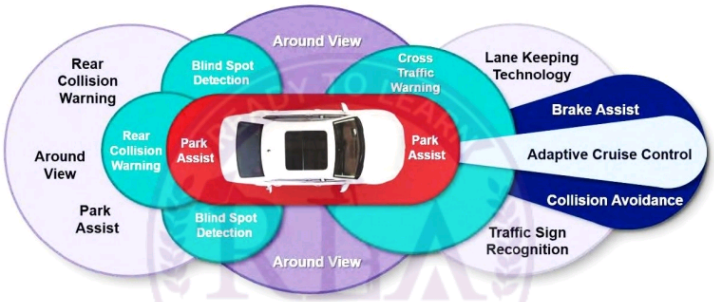


Fig:3 Town bus

Advanced Driver Assistance System (ADAS)

1. Introduction to ADAS

Advanced Driver Assistance System (ADAS) refers to a suite of technologies that are designed to enhance the safety and driving experience of a vehicle. ADAS includes a variety of electronic systems that assist drivers in the driving process, ensuring higher levels of safety, comfort, and convenience. The primary goal of ADAS is to reduce human error, prevent accidents, and increase driving efficiency. These systems use a combination of sensors, cameras, radar, LIDAR, and other technologies to monitor the vehicle's surroundings and provide feedback to the driver or even control certain aspects of the vehicle.



2. Key Features of ADAS

ADAS technologies cover a wide range of features, from basic safety systems to more advanced semi-autonomous driving capabilities. Some of the key features of ADAS are:

A. Adaptive Cruise Control (ACC)

- **Function:** ACC adjusts the speed of the vehicle to maintain a safe following distance from the vehicle ahead. It uses radar and sensors to detect the distance between your vehicle and the one in front and automatically adjusts the vehicle's speed to maintain a pre-set distance.
- **Application:** On highways or long-distance drives, ACC can help reduce the driver's workload by automatically maintaining a safe following distance and adjusting the speed accordingly.

B. Lane Departure Warning (LDW) and Lane Keep Assist (LKA)

Lane Departure Warning (LDW):

- **Function:** LDW alerts the driver if the vehicle unintentionally drifts out of its lane without signaling. It typically uses cameras mounted on the front windshield to monitor lane markings on the road.
- **Application:** This system helps to avoid accidents caused by distracted or tired driving.

Lane Keep Assist (LKA):

- **Function:** LKA can actively steer the vehicle back into its lane if it detects unintentional lane departure. This is an extension of the LDW, as it not only warns the driver but also takes corrective action.
- **Application:** This system is particularly useful in preventing collisions in case of driver inattention or fatigue.

C. Collision Warning System

- **Function:** The collision warning system uses radar, cameras, and LIDAR to m traffic in front of the vehicle. If a potential collision is detected, the system ale driver through visual or audible warnings.
- **Application:** This system helps drivers recognize potential risks of rear-end collisions, giving them enough time to take preventive actions.

D. Automatic Emergency Braking (AEB)

- **Function:** AEB works in conjunction with the collision warning system and is designed to automatically apply the brakes if a collision is imminent and the driver has not

Special vehicles

1. Introduction to Special Vehicles

Special vehicles are designed and built to meet specific needs that cannot be fulfilled by standard vehicles. These vehicles are customized or modified for unique purposes, ranging from emergency services, military use, industrial applications, and transporting heavy or hazardous loads. In the context of body building technology, special vehicles are often created with enhanced capabilities, safety features, or functionality that regular vehicles do not possess.

With advancements in materials, technology, and engineering practices, the design and production of special vehicles have become more sophisticated. They are now capable of performing a broader range of tasks with higher efficiency, safety, and cost-effectiveness.

2. Types of Special Vehicles

Special vehicles can be broadly categorized based on their application and the specific requirements they are designed to meet. Some of the most common categories of special vehicles include:

A. Emergency and Rescue Vehicles

1. Ambulance Vehicles

- Purpose: Emergency medical service (EMS) vehicles are used for transporting patients to hospitals or healthcare facilities.
- **Design Features:**
  - ✓ Equipped with medical equipment such as stretchers, oxygen tanks, and emergency medication.
  - ✓ Often include sirens, flashing lights, and other features to navigate through traffic quickly.

The interior is designed to provide a controlled environment for patients with space for emergency treatment.

2. Fire Fighting Trucks

- **Purpose:** Specialized vehicles used by fire departments to respond to fires and rescue operations.
- **Design Features:**
  - ✓ Large water tanks, hoses, and pump systems to fight fires.
  - ✓ The cab and crew area are designed to allow easy access to fire-fighting equipment.
  - ✓ - Foam systems and rescue tools like ladders and hydraulic cutters are often included.

3. Rescue and Recovery Vehicles

- **Purpose:** These vehicles are used for specialized rescue operations such as road accidents, natural disasters, or military operations.
- Design Features:
  - ✓ Equipped with cranes, winches, or hydraulic systems for lifting or towing heavy objects.
  - ✓ Includes safety features such as reinforced structures and emergency lighting.
  - ✓ Often designed with high ground clearance for rough terrain operations.

B. Military and Defence Vehicles

1. Armored Vehicles

- **Purpose:** Military vehicles designed to protect their crew from gunfire, explosions, and other hazards.
- **Design Features:**
  - ✓ Thick, reinforced body Armor made of steel or composite materials.
  - ✓ Bulletproof windows and special suspension systems to handle rough terrains.
  - ✓ Used for transportation of troops, equipment, or for

Maintenance and safety on painting

1. Introduction to Painting in Vehicle Body Building

Painting is a critical process in vehicle body building technology. It serves multiple purposes, including enhancing the aesthetic appeal of the vehicle, protecting the metal surfaces from corrosion, and improving its durability against harsh environmental conditions. Painting also plays an essential role in identifying and marking the vehicle with the brand, model, and other important identifiers.

However, the painting process requires significant attention to detail and safety due to the chemicals and equipment involved. Therefore, maintaining the painting equipment properly and adhering to safety protocols is crucial for ensuring the quality of the painting process and the health of workers.

2. Importance of Maintenance in Painting

Effective maintenance in the painting process is essential for:

Ensuring High-Quality Finish:

Proper maintenance of the painting equipment ensures that the paint is applied evenly and without defects, such as bubbles, streaks, or uneven coats.

Minimizing Downtime:

Routine maintenance prevents unexpected breakdowns, reducing downtime and improving the productivity of the painting process.

Optimizing Equipment Longevity:

Well-maintained painting systems and tools last longer, thus saving costs on repairs or replacements.

Cost Efficiency:

Efficient use of materials, such as paint and solvents, helps reduce wastage and lowers the overall cost of the process.

3. Types of Painting in Vehicle Body Building

There are several types of painting methods used in vehicle body building:

1. Spray Painting:

- **Description:** This is the most common method used in the automotive industry. Paint is applied using a spray gun that atomizes the paint, creating a fine mist that is evenly sprayed onto the surface of the vehicle.
- **Maintenance Concerns:** Regular cleaning of the spray guns, filters, and compressors is required to prevent clogs and ensure the smooth application of paint.

2. Electrostatic Painting:

- **Description:** In this process, paint particles are charged and sprayed onto a grounded vehicle part. This technique ensures even coating and minimizes wastage.
- **Maintenance Concerns:** The electrostatic system, including the power supply and spray gun, must be regularly inspected and cleaned.

3. Dipping:

01. Leadership - Morale - Motiv...
Modified Aug 24, 2024

02. Depreciation calculation usi...
Modified Aug 24, 2024

03. Material Management-ABC ...
Modified Aug 24, 2024

04. Goods Transport.pdf
Modified Aug 24, 2024

05. Operational Layout of servi...
Modified 9:38 AM

06. Bus stand- Classifications....
Modified 9:36 AM

07. Passenger Transport & Pas...
Modified Aug 24, 2024

08. Fare calculation and fare c...
Modified 9:59 AM

09. Motor vehicles act - Salient.
Modified 10:10 AM

10. Road Signals & Traffic Signa...
Modified Aug 24, 2024

11. Permit.pdf
Modified Aug 24, 2024

12. Registering Vehicle.pdf
Modified Aug 24, 2024

13. Fitness Certificate.pdf
Modified Aug 24, 2024

14. Insurance & Types of Policy....
Modified 10:25 AM

15. Certificate of Insurance - A...
Modified 10:35 AM

16. Costing In Road Transport.p...
Modified Aug 24, 2024

17. Running cost.pdf
Modified 10:45 AM

New

Negative Motivation

- It is a pull mechanism
- Giving fear to the workers.
    - Loss of wages
    - Job security
    - Promotion delay
    - No allowance
    - Reduction in wages, allowances.

THREE DIMENSIONS OF MOTIVATIONS:-

a) Physical dimension
b) Social dimension
c) Ideological dimension.

a) **Physical Dimensions**

Relates to basic needs like food, cloth, shelter etc.

b) Social Dimensions:-

Relates social needs like status, job security, importance in job etc.

c) Ideological Dimensions:-

Relates to physic like achievement of mental satisfaction.

LEADERSHIP:

Leadership: Guiding the sub-ordinates by proper way to achieve the company goals.

TYPES OF LEADERSHIP:

- Authorization leadership.
- Democratic leadership.
- Free rein or Laissez fair leadership.

1. Authorization leadership:

- In this type of leadership the leader takes decisions by himself.
- Full authority is held by the leader..
- Subordinates should follow his directions without any questions.
- Negative motivation is used in this leadership.

Merits:

GOODS TRANSPORT OPERATION

3.1 GOODS TRANSPORT OPERATION

- A party (usually a buyer) named by the consignor (usually a seller) in transportation documents as the party to whose order a consignment will be delivered at the port of destination.
- The consignee is considered to be the owner of the consignment for the purpose of filing the customs declaration, and for paying duties and taxes.
- Formal ownership of the consignment, transfers to the consignee only upon payment of the seller's invoice in full.
- Consignor (sender): A person who sends the goods and parcel. Consignee (receiver): A person who receives the goods and parcel.
- The movement of goods from consignor to consignee through goods transport vehicle is called goods transport operation.

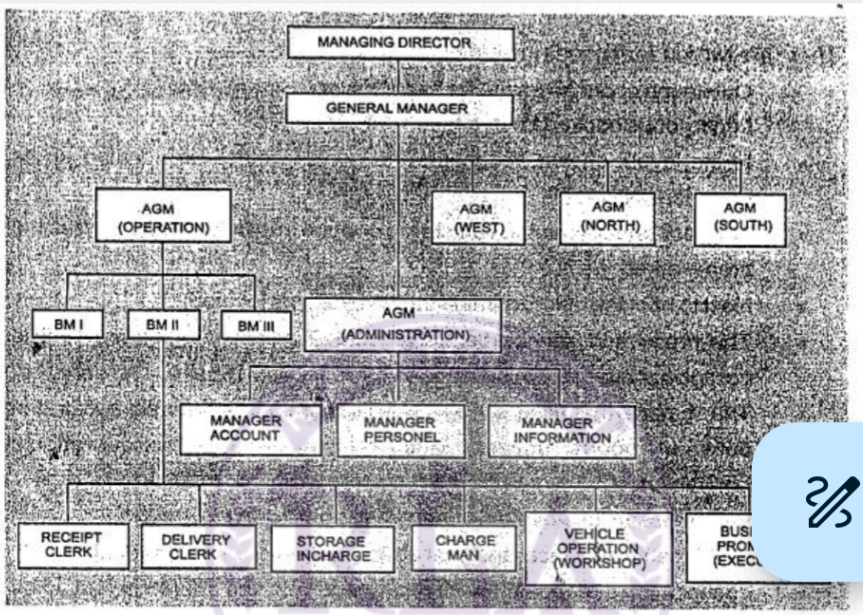
The various types of goods transport operations are

1. Lorry transport
2. Train transport
3. Ship and air service
4. Courier service.

3.2 ADMINISTRATIVE SETUP FOR GOODS TRANSPORT OPERATION

The layout describes a goods transport hierarchy. In this layout General Manager is the top most authority. He has the power to control the entire transport depot. Under his control the powers are shared by 3 divisional AGM's (such as west, north, south divisions), AGM operation and AGM administration.

- AGM (operation) controls 3 branch managers. They in turn control the receipt clerk, delivery clerk, storage in charge, charge man etc.
- AGM (administration) controls manager accounts, manager personnel and manager information.



3.3 LAYOUT OF GARAGE AND DEPOT FOR GOODS TRANSPORT VEHICLE

Motor Vehicle Act – Salient features

1. Introduction to the Motor Vehicles Act (MVA)

The Motor Vehicles Act (MVA), enacted in 1988, is a crucial legislation governing road transport in India. It provides a framework for the regulation of vehicles, their use on public roads, traffic rules, licensing, and penalties for violations. The Act aims to ensure road safety, reduce accidents, regulate vehicle standards, and ensure proper registration, insurance, and licensing.

The Act has been amended several times to keep up with technological advancements, traffic concerns, and the increasing number of vehicles on Indian roads.

2. Objective of the Motor Vehicles Act

The main objectives of the Motor Vehicles Act are:

- ✓ To ensure road safety by enforcing strict traffic rules and regulations.
- ✓ To regulate the registration and licensing of vehicles and drivers.
- ✓ To ensure the proper maintenance and fitness of vehicles, especially commercial ones.
- ✓ To impose penalties for violations to ensure discipline on the roads.
- ✓ To set out insurance requirements for all vehicles.
- ✓ To ensure proper traffic control through the regulation of public transport systems.

3. Salient Features of the Motor Vehicles Act

The Motor Vehicles Act (1988) covers various aspects of road safety, vehicle management, and penalties for traffic violations. The salient features of the Act include:

A. Registration of Vehicles

- **Section 39** of the MVA mandates that every vehicle used on public roads must be registered with the Regional Transport Office (RTO) of the respective state.
- **Registration certificates (RC) serve as the official proof of registration.**
- All vehicles, whether for personal use or commercial use, must be registered, and commercial vehicles must carry the permit required to operate on specific routes.

B. Licensing of Drivers and Conductors

- **Section 3** of the MVA requires every person driving a motor vehicle to possess a valid driving license (DL).
- **Driving licenses are issued by the RTO after a proper driving test that assesses a person's knowledge of traffic rules and road safety.**
- Drivers of transport vehicles like buses and trucks need special licenses, which include additional testing for professional driving skills.

C. Traffic Rules and Regulations

The MVA lays down important traffic rules for safe driving. Some of these include:

- ➢ **Speed limits:** Different speed limits are prescribed for different types of vehicl roads (e.g., highways, urban roads, residential areas).
- ➢ **Seat belts:** It is mandatory for the driver and front-seat passengers to wear seat Failure to do so is a punishable offense.
- ➢ **Helmets:** Riders of two-wheelers must wear helmets. Non-compliance is penaliz
- ➢ **Drunken driving:** There are strict penalties, including suspension of the drive license and fines, for driving under the influence of alcohol or drugs.
- ➢ Pedestrian crossings: Vehicles must stop for pedestrians at marked crossings.

D. Insurance Requirements

- The Act makes it compulsory for all vehicles to have at least third-party liability

Running Costs

1. Introduction to Running Costs in Road Transport

The running cost in road transport refers to the ongoing costs that are incurred during the operation of vehicles for the transportation of goods and passengers. These costs can be incurred by both personal vehicle owners and commercial fleet operators, such as bus services, freight operators, and transport companies.

Running costs are crucial to determine the economic viability of operating vehicles in the road transport sector. These costs are directly linked to fuel consumption, maintenance, driver wages, insurance, and various other factors that influence the cost of transportation services.

In India and Tamil Nadu, road transport is one of the most commonly used modes of transportation, and understanding the breakdown of running costs is essential for efficient management and operations.

2. Components of Running Costs in Road Transport

The running costs of road transport are made up of several components. These include:

A. Fuel Costs

- Fuel is one of the most significant running costs for road transport vehicles. The type of fuel used (e.g., diesel, petrol, CNG, LPG) greatly impacts the overall fuel cost.
  - **Fuel Efficiency:** The fuel efficiency of the vehicle (measured in km/l for passenger vehicles and liters per ton-km for freight vehicles) directly influences fuel expenses.
  - **Fuel Price:** The price of fuel fluctuates based on government taxes, global oil prices, and other factors, and it significantly impacts running costs.
- In India and Tamil Nadu, the fuel prices have been volatile due to changes in the global crude oil market. For instance, diesel is commonly used in commercial vehicles, and its cost can account for a substantial part of the total operating cost.

B. Maintenance and Repair Costs

- Vehicles require regular maintenance to ensure efficient operation. Maintenance costs can include:
  - **Routine Maintenance:** This includes oil changes, tire rotations, brake checks, and other scheduled services.
  - **Repairs:** Unexpected repairs due to mechanical failure, accidents, or wear and tear add to the cost.
  - **Parts Replacement:** Over time, vehicle parts like brakes, tires, batteries, and filters need to be replaced, which adds to the running cost.
- In Tamil Nadu, like other states, the frequency of repairs and the costs of spare parts can vary depending on the vehicle model and type.

C. Driver and Labour Costs

- The labour cost, particularly the wages of drivers and other staff, is another significant part of the running cost for road transport. It includes:
  - **Driver Salaries:** The salary paid to the driver is a fixed cost that remains constant.
  - **Other Labour Costs:** For freight and commercial vehicles, there may be additional labour costs such as helpers, loaders, or mechanics.
- In Tamil Nadu, the labour cost can be higher in urban areas like Chennai due to the h… living costs. It's important to note that driver salaries may also depend on the ty… vehicle, operating hours, and the distance travelled.

D. Vehicle Depreciation

- Depreciation refers to the reduction in the value of a vehicle over time due to wear and tear, aging, and market conditions. This is a non-cash cost but still needs to be considered for long-term operational planning.
  - **Depreciation Rate:** The rate at which a vehicle depreciates depends on the make and model, the vehicle's usage, and the maintenance schedule.
  - **Effect on Running Costs:** Higher depreciation means more cost recovery for the vehicle owner, increasing the overall running cost.