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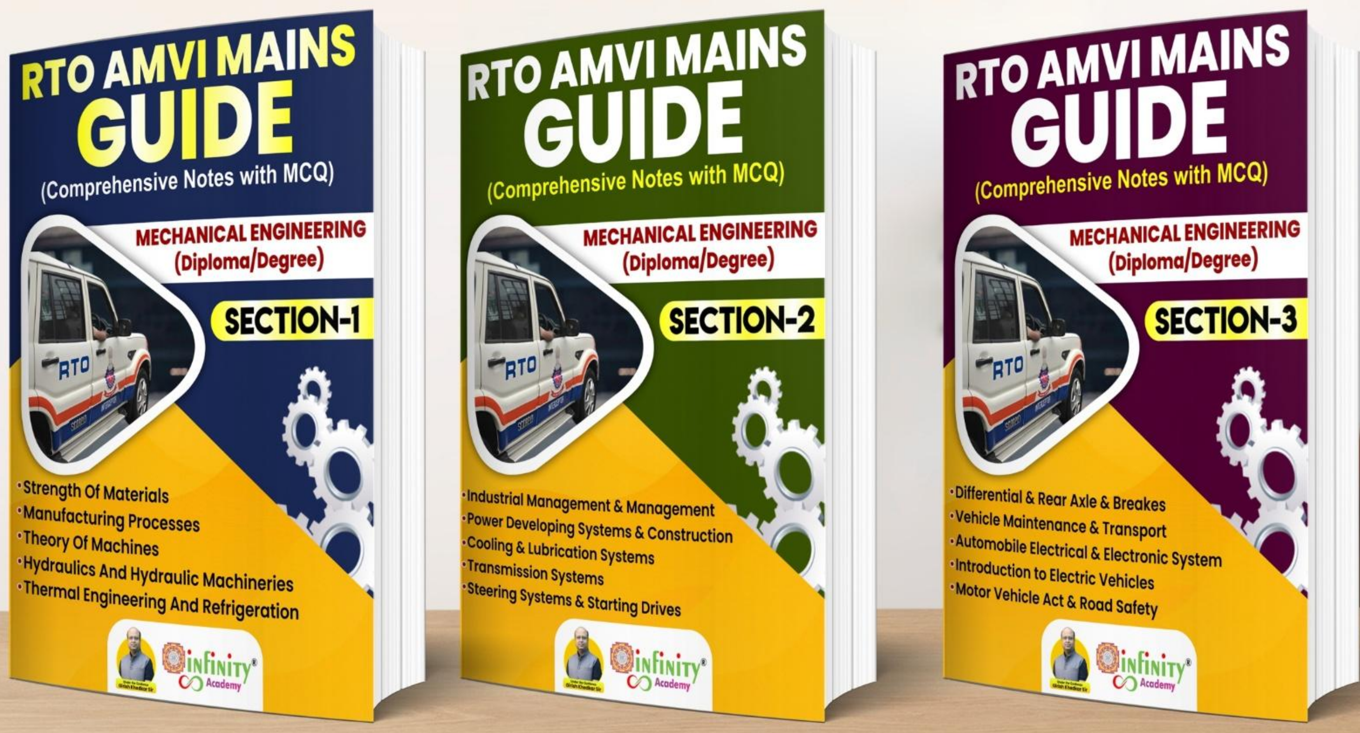
SET OF 3 BOOKS



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RTO AMVI MAINS GUIDE

Comprehensive Notes with MCQ

SECTION-1

- Strength Of Materials
- Manufacturing Processes
- Theory Of Machines
- Hydraulics And Hydraulic Machineries
- Thermal Engineering And Refrigeration

प्रकाशक

Infinity Publications, Pune

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अक्षरजुळणी, सजावट व मुखपृष्ठ

Team Infinity

We Have made all possible effort to make this book error free however it is request to all students, if you find any error or want to give suggestions that we can incorporate into future editions, feel free Send us email girish@infinitycivilacademy.com

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श्री स्वामी समर्थ...

स्वामींच्या चरणी अर्पण ...

PREFACE

RTO AMVI या पदासाठीच्या मुख्य परीक्षेच्या बदललेल्या अभ्यासक्रमामध्ये एकूण 15 तांत्रिक विषय समाविष्ट आहेत या सर्व विषयाची तयारी करायची असेल तर विद्यार्थ्याला खूप सारे पुस्तके हाताळावी लागतात , त्यात योग्य अभ्याससाहित्य शोधण्यात विद्यार्थ्यांचा वेळ वाया जातो. या सर्व गोष्टी विचारात घेऊनच या तयारीसाठी लागणाऱ्या व विद्यार्थ्यांच्या अभ्यासाच्या सर्व गरजा पूर्ण करणाऱ्या पुस्तकाचा संच आम्ही सादर करीत असतांना आम्हाला विशेष आनंद होत आहे.

सदर पुस्तकाचा संच नवीन अभ्यासक्रमावर आधारित असून प्रत्येक घटक योग्य पद्धतीने विद्यार्थ्यांना आकलन होईल अश्या सोप्या सहज भाषेत मांडले आहेत. RTO AMVI मुख्य परीक्षा ही स्पर्धक विद्यार्थ्यांसाठी अत्यंत महत्त्वपूर्ण टप्पा असतो कारण याचेच गुण तुम्हाला पद मिळवून देणारे असतात ,अभ्यास साहित्य निवड करतानाची साधी चूक सुद्धा तुम्हाला शर्यतीतून बाहेर करू शकते.

एकूण 15 विषयांचे 3 ग्रुप तयार करून 3 पुस्तके या संचात समाविष्ट आहेत , तज्ञ व अनुभवी शिक्षकवर्ग यांनी या पुस्तकासाठी काम केले आहे. शासनामध्ये निवड झालेले विद्यार्थी व अधिकारी वर्ग यांनी या संचांचे अवलोकन करून गुणवत्तापूर्ण संच तयार केला व पुस्तकाला यशाच्या दृष्टीने योग्य उंचीवर नेवून ठेवले आहे. या संचात घटकनिहाय बहुपर्यायी प्रश्न व उत्तरे दिली आहेत ज्यामुळे विद्यार्थ्यांना सराव करताना खूप फायदा होईल.

पुस्तकात सर्वोतोपरी त्रुटी काढून टाकण्याचा प्रयत्न केला आहे तरी काही त्रुटी आढळून आल्यास संपर्क करावा .

infinitycontent2017@gmail.com

आपला

गिरीश खेडकर

SYLLABUS

Sr.no	SUBJECT NAME
1.	**Strength of Materials :** Simple stress, strain energy, shearing force and bending moment, moment of inertia, Principal planes and stresses, slope, and deflection. Direct and bending stresses, Theory of torsion, assumptions, torsional stresses, and strains
2.	**Manufacturing Processes:** Engineering materials and their properties, Metal cutting process: Turning, Drilling, Milling, Boring, Broaching, Finishing and super finishing. Plastics and their processing Metal joining processes, NC-CNC, and non-conventional machining methods.
3.	**Theory of Machines :** Kinematics and dynamics of machines, role of friction, power transmission equipment such as fly wheel, clutch, belt drive and governors. Principle of gyroscopes and its effects, Applications of cams.
4.	**Hydraulics and hydraulic machineries**: - Fluids and their properties, Laminar and turbulent flow, Bernoulli's Equation, Fluid Pressure, Pascal's Law, Surface tension, fluid flow and its measurement. Hydraulic turbines, Hydraulic pumps
5.	**Thermal Engineering and refrigeration** **Sources of energy:** Conventional and non-conventional, Laws of thermodynamics, Principle and working of heat engines, air compressors. Air Standard, vapors power and Gas power cycles. Refrigerator and heat pump, Vapor compression and vapor absorption refrigeration system.
6.	**Industrial Engineering and Management:** Types of Management and organization and their functions, Industrial acts, Types of production, plant layouts, process planning, work study, statistical quality control, Metrology.
7.	**Power Developing Systems and construction:** chassis, layout types, Sub-systems of automobile SI/CI -Two stroke, four stroke construction and working, types of Chassis and frames CRDI, MPFI system, Fuel pumps and fuel injector ECU for CI engine, Ignition systems used in the automobile
8.	**Cooling and Lubrication systems:** Cooling system: purpose, types of cooling system, troubles, and remedies of cooling system. lubrication systems: - Types of lubricants, multi viscosity oils, chassis lubrication. Engine lubrication: -types of lubricating systems, crankcase ventilation, Engine lubrication troubles and remedies
9.	**Transmission systems:** Construction and working of single plate, multi-plate, cone clutch, centrifugal clutch. Faults and remedies/repairs of clutches. Gear Box – Construction and working of sliding mesh, constant mesh, synchromesh, torque converter, Faults, and remedies/repairs of gear box
10.	**Steering Systems and starting drives:** Front axle, types of stub axle, steering geometry, Ackerman's mechanism. Under steer, over steer, steering linkage. Type of steering gears, Power steering wheel alignment, wheel balancing starter motor drive-Bendix drive, over running clutch drive, follow thru drive Construction and working of dynamo and alternator, specifications of alternator Cutouts, relay, and regulator.
11.	**Differential, rear axle and brakes:** Differential - function, construction, working principal, Transfer case Types of rear axle: - semi-floating, full floating bearing, three quarter floating axle Types of brakes: - drum

	brakes, disk brakes. Hand Brake/ Parking Brake. hydraulic, air brakes, Brake troubleshooting, ABS
12.	**Vehicle maintenance and Transport Management:** Performance of vehicles, engine electrical and electronics, workshop layout, repairing and servicing, Emission measurements and control techniques. Elements of transport and its operations.
13.	**Automobile Electrical and Electronic systems**, Battery, Starting system, Alternators, Charging, Inspection, and maintenance of electrical systems.
14.	**Introduction to Electric Vehicles:** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles: - Battery based energy storage, Battery Specifications, Battery Management System
15.	**Motor Vehicle Act and Road Safety** Introduction to Vehicle Act and Road Safety, Licensing, registration, Motor Vehicle Act, Taxation, Insurance etc Organization structure of RTO Department, Passenger comfort and safety

INDEX

STRENGTH OF MATERIALS

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SYLLABUS

1.1 Stress and Strain,

1.2 Strain Energy

1.3 Shearing Force and Bending Moment

1.4 Moment of Inertia

1.5 Principal Planes and Stresses

1.6 Slope and Deflection

1.7 Direct and Bending Stresses

1.8 Torsion.

1.9 Column

1.10.Thin Pressure Cylinder

PREVIOUS YEAR QUESTIONS

YEAR	NO. OF QUSTIONS
2020	15
2017	15
2013	15
2011	15
2005	10
2004	10
2003	10
1998	10

1.1 SIMPLE STRESS

MECHANICAL PROPERTIES OF MATERIALS

Some important mechanical properties are:

1. Strength
2. Elasticity
3. Plasticity
4. Ductility
5. Brittleness
6. Malleability
7. Impact strength
8. Hardness
9. Stiffness
10. Fatigue
11. Creep

STRENGTH:

The strength of a material is its ability to sustain loads without undue distortion, collapse or rupture. A material should have adequate strength when subjected to tension, compression, shear, bending or torsion as per the intended use. For example, a beam of a building should have a proper bending strength, a column should have adequate compressive strength, and a shaft of an automobile should have proper torsional strength. The maximum stress that any material will withstand is called **ultimate strength or tenacity**.

ELASTICITY:

It is the property of a material by virtue of which it regains its original size and shape after deformation, when the loads causing deformation are removed.

PLASTICITY:

Lack of elasticity is called plasticity. The plasticity of a material is the ability to change its shape without destruction under the action of external loads and to regain the shape given to it when the forces are removed

DUCTILITY:

It is the property of a material to undergo a **considerable deformation under tension before rupture**. A body possessing ductility can be reduced from large sections to thinner and thinner sections i.e. **it can be drawn into wires**. This is a tensile quality of a material.

BRITTLENESS:

Lack of ductility is called brittleness. The brittleness of a material is the property of breaking, fracturing or shattering without prior warning or without much permanent distortion under load.
E.g. cast iron, glass, concrete, stone, etc.
These materials are suitable for resisting compressive loads.
Usually less suitable for resisting tensile and impact loads.
Brittleness is a compressive quality of a material.

MALLEABILITY:

It is the property of a material by virtue of which it gets permanently deformed by compression without rupture.
It is the ability of a material to be **rolled or beaten up into thin sheets** without cracking by rolling and hammering.
This is also a compressive quality of a material.
e.g. **Gold** is the most malleable of all metals. Silver, aluminum, copper, tin are also malleable materials.

IMPACT STRENGTH:

The amount of shock energy absorbed by a specimen before it fractures is called its impact strength or toughness.

Izod and charpy impact tests are generally conducted to measure the toughness of a material.

The energy required to break the given specimen is measured in joules (N - m).

HARDNESS:

The ability of a material to resist wear, abrasion, scratching or indentation (penetration) by harder bodies is called hardness.

Tests such as **Brinell, Rockwell, Vickers** are generally performed to measure the hardness of a material.

FATIGUE:

A material may fail under fluctuating or repeated loads (or stresses) even though the maximum applied stress is considerably less than the tensile strength of the material under steady loads.

This phenomenon of failure of a material under **fluctuating or repeated loading** is called fatigue or endurance.

Fatigue fracture is progressive, and starts as minute cracks at the centres of stress concentration within the material or on the surface. These cracks go on extending more and more under the action of fluctuating stresses causing the failure.

The maximum stress that a material can sustain without failure for a specific large number of cycles of stresses is known as its **fatigue value or endurance limit.**

CREEP:

The continuous deformation with **time** which the material undergoes due to application of **external steady loads** is called creep or time yield or plastic flow.

STIFFNESS:

The ability of a material to resist **elastic deformation** is called stiffness.

It is the load required to produce unit deformation.

A material which deforms by a lesser amount under a given load possesses a high degree of stiffness.

For identical cross-sections, the stiffness is proportional to the modulus of elasticity.

1.STRESS:

It is the internal resistance offered by the body to deformation due to externally applied load.

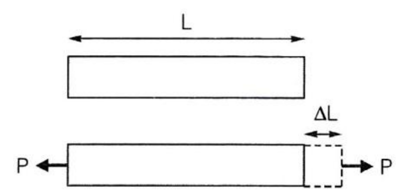
Nominal stress = ${Load}/{\text{Original Area}}$

$Actual/True$ stress = ${Load}/{\text{Actual Area}}$

Unit:- N/m^2

2.STRAIN:

Deformation per unit length in the direction of deformation is known as strain.



$$Strain = \frac{\Delta L}{L}$$

Unit :- It is a dimensionless quantity.

PRACTICE QUESTIONS

1. The stress induced in a body, when suddenly loaded, is---- the stress induced when the same load is applied gradually.

A. equal to B. one-half
C. twice D. four times

2. On principal plane the shear stress is...........
A. zero
B. unity
C. double the value of principal stress

THERMAL ENGINEERING AND REFRIGERATION

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5.THERMAL ENGINEERING

SYLLABUS

5.1 Conventional and Non-Conventional

5.2 Laws of Thermodynamics,

5.3 Principle and Working of Heat Engines,

5.4 Air Compressors.

5.5 Air Standard Cycles,

5.6 Air Refrigeration Cycles

5.7 Vapour Compression and Vapour Absorption Refrigeration System.

5.8 Refrigerant

PREVIOUS YEAR QUESTIONS

YEAR	NO. OF QUSTIONS
2020	20
2017	20
2013	20
2011	18
2005	25
2004	13
2003	19
1998	13

5.1 THERMAL ENGINEERING AND REFRIGERATION

INTRODUCTION

FUNDAMENTAL OF THERMODYNAMICS

What Is Thermodynamics?

Thermodynamics can be defined as the science of energy.

The name thermodynamics stems from the Greek words therme (heat) and dynamis (power), which is most descriptive of the early efforts to convert heat into power.

One of the most fundamental laws of nature is the conservation of energy principle. It simply states that during an interaction, energy can change from one form to another but the total amount of energy remains constant.

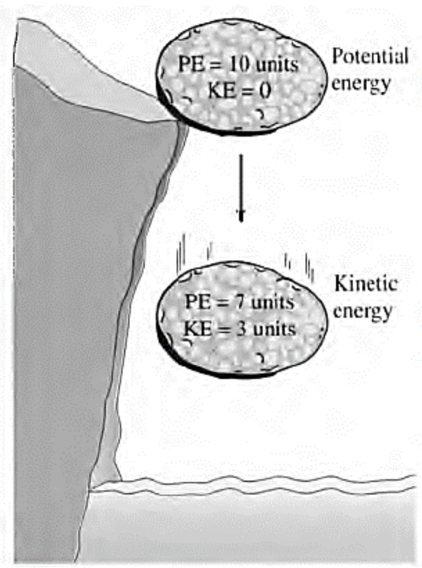

FIGURE 1
Energy cannot be created or destroyed; it can only change forms (the first law).

That is, energy cannot be created or destroyed. A rock falling off a cliff, for example, picks up speed as a result of its potential energy being converted to kinetic energy (Fig.).

The conservation of energy principle also forms the backbone of the diet industry: A person who has a greater energy input (food) than energy output (exercise) will gain weight (store energy in the form of fat), and a person who has a smaller energy input than output will lose weight (Fig.). The change in the energy content of a body or any other system is equal to the difference between the energy input and the energy output, and the energy balance is expressed as $E_{in} - E_{out} = \Delta E$.

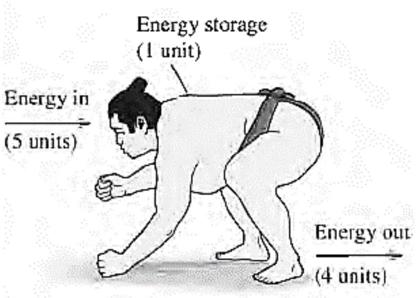

FIGURE 2
Conservation of energy principle for the human body.

The first law of thermodynamics is simply an expression of the conservation of energy principle, and it asserts that energy is a thermodynamic property.

The second law of thermodynamics asserts that energy has *quality* as well as *quantity,* and actual processes occur in the direction of decreasing quality of energy. For example, a cup of hot coffee left on a table eventually cools, but a cup of cool coffee in the same room never gets hot by itself (Fig). The high-temperature energy of the coffee is degraded (transformed into a less useful form at a lower temperature) once it is transferred to the surrounding air.

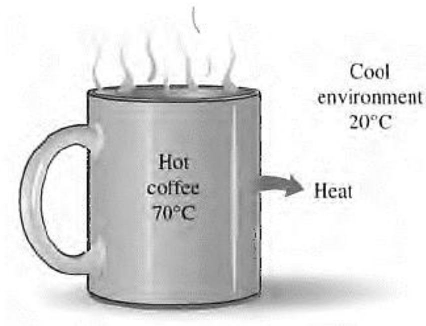

FIGURE 3
Heat flows in the direction of decreasing temperature.

Although the principles of thermodynamics have been in existence since the creation of the universe, thermodynamics did not emerge as a science until the construction of the first successful atmospheric steam engines in England by Thomas Savery in 1697 and Thomas Newcomen in 1712. These engines were very slow and inefficient, but they opened the way for the development of a new science.

APPLICATION AREAS OF THERMODYNAMICS

Thermodynamics is commonly encountered in many engineering systems and other aspects of life, and one does not need to go very far to see some application areas of it. In fact, one does not need to go anywhere.

The heart is constantly pumping blood to all parts of the human body, various energy conversions occur in trillions of body cells, and the body heat generated is constantly rejected to the environment. The human comfort is closely tied to the rate of this metabolic heat rejection. We try to control this heat transfer rate by adjusting our clothing to the environmental conditions.

Many ordinary household utensils and appliances are designed, in whole or in part, by using the principles of thermodynamics.

Some examples include the electric or gas range, the heating and air-conditioning systems, the refrigerator, the humidifier, the pressure cooker, the water heater, the shower, the iron, and even the computer and the TV.

On a larger scale, thermodynamics plays a major part in the design and analysis of automotive engines, rockets, jet engines, and conventional or nuclear power plants, solar collectors, and the design of vehicles from ordinary cars to airplanes

The size, location, and the power input of the fan of your computer is also selected after an analysis that involves thermodynamics.

MACROSCOPIC AND MICROSCOPIC POINTS OF VIEW

Thermodynamic studies are undertaken by the following two different approaches.

1. Macroscopic approach—(*Macro* mean *big* or *total*)

2. Microscopic approach—(*Micro* means *small*)

S.No	Macroscopic approach	Microscopic approach
1	In this approach a certain quantity of matter is considered *without* taking into account the events occurring at molecular level. In other words this approach to thermodynamics is concerned with *gross or overall behaviour*. This is known as *classical thermodynamics*.	The approach considers that the system is made up of a very large number of discrete particles known as molecules. These molecules have different velocities and energies. The values of these energies are constantly changing with time. This approach to thermodynamics which is concerned directly with the structure of the matter is known as

C. 2 only D. 1 only

31. According to Dalton's law, the total pressure of the mixture of gases is equal to
A. greater of the partial pressure of gases
B. average of the partial pressure of gases
C. Sum of the partial pressure of all
D. Sum of the partial pressure of all divided by average molecular weight

32. Joule-Thomson coefficient is defined as:
A. $\left(\frac{\partial T}{\partial P}\right)_h$ B. $\left(\frac{\partial H}{\partial P}\right)_T$
C. $\left(\frac{\partial H}{\partial T}\right)_P$ D. $\left(\frac{\partial P}{\partial T}\right)_h$

33. Which relationship defines Gibbs free energy G:
A. G=H+TS B. GH-TS
C. G = U+TS D. F = U+TS

34. Joule-Thomson coefficient for an ideal gas is
A. higher than zero B. less than zero
C. zero D. 1

35. A gas having a negative Joule-Thomson effect ($\mu < 0$), when throttled will :
A. Become cooler
B. Become warmer
C. Remain in the same temperature
D. Become Cooler or warmer depending upon the type of gas

36. The Helmholtz function F is defined as
A. F = H+TS B. F=H-TS
C. F= U+ TS D. F = U-TS

ANSWER KEY

Que.	Ans.	Que.	Ans.	Que.	Ans.	Que.	Ans.
1	C	11	C	21	B	31	C
2	D	12	B	22	B	32	A
3	A	13	C	23	D	33	B
4	D	14	D	24	A	34	C
5	D	15	C	25	A	35	B
6	A	16	B	26	C	36	D
7	B	17	C	27	C		
8	A	18	C	28	A		
9	B	19	D	29	A		
10	C	20	A	30	C		

RTO AMVI MAINS GUIDE

Comprehensive Notes with MCQ

SECTION-2

- Industrial Management & Management
- Power Developing Systems & Construction
- Cooling & Lubrication Systems
- Transmission Systems
- Steering Systems & Starting Drives

INDEX

INDUSTRIAL ENGINEERING AND MANAGEMENT

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6.1 MANAGEMENT AND ORGANIZATION

INTRODUCTION TO MANAGEMENT:

Management is a fundamental process that exists in all organizations, whether large corporations, small businesses, government agencies, or non-profit entities. It involves coordinating and overseeing the activities of people and resources to achieve specific goals and objectives. The field of management is dynamic, encompassing a wide range of functions and responsibilities, and it plays a crucial role in the success and sustainability of organizations.

Management is a multifaceted discipline that involves planning, organizing, leading, and controlling resources to achieve organizational goals. Successful management requires a combination of technical expertise, interpersonal skills, and the ability to adapt to evolving challenges in the business environment.

KEY ELEMENTS OF MANAGEMENT:

1. Planning:

- Planning is the process of setting objectives, defining strategies, and outlining tasks to achieve organizational goals. It involves determining what needs to be done, when, and how.

2. Organizing:

- Organizing involves arranging resources, including human resources, finances, and materials, to implement the plans effectively. This includes creating structures, establishing roles, and allocating responsibilities.

3. Leading (or Directing):

- Leading is about motivating, guiding, and influencing individuals or teams to work towards the organization's goals. It includes communication, decision-making, and fostering a positive and productive work environment.

4. Controlling:

- Controlling is the process of monitoring and evaluating ongoing activities to ensure they align with the established plans. It involves taking corrective actions when necessary to keep activities on track.

FUNCTIONS OF MANAGEMENT:

1. Top-Level Management:

- Top-level management, also known as strategic management, focuses on the overall direction and strategy of the organization. It involves making long-term decisions that shape the organization's future.

2. Middle-Level Management:

- Middle-level management is responsible for implementing the strategies and plans developed by top-level management. It acts as a bridge between top-level and front-line management.

3. Front-Line (Supervisory) Management:

- Front-line managers are directly involved in overseeing the day-to-day activities of non-managerial employees. They play a crucial role in ensuring that tasks are completed efficiently and according to plans.

SKILLS REQUIRED FOR EFFECTIVE MANAGEMENT:

1. Technical Skills:

- The ability to apply specific knowledge and expertise related to the organization's industry or field.

2. Interpersonal Skills:

- Effective communication, leadership, and relationship-building skills are essential for managing and working with diverse teams.

3. Conceptual Skills:

- The ability to think strategically, analyse situations, and make decisions that align with the organization's goals.

4. Time Management:

- Efficient use of time and resources to meet deadlines and achieve objectives.

CHALLENGES IN MANAGEMENT:

1. Globalization:

- Managing operations and teams across borders presents challenges related to cultural differences, legal requirements, and diverse business environments.

2. Technological Changes:

- The rapid pace of technological advancements requires managers to adapt to new tools and processes to remain competitive.

3. Workforce Diversity:

- Managing diverse teams with individuals from various backgrounds requires skills in fostering an inclusive and collaborative work environment.

4. Ethical Dilemmas:

- Managers often face ethical decisions and must navigate complex situations to ensure the organization's integrity.

Types of management are not mutually exclusive, and in practice, managers often perform multiple roles based on the needs of the organization. Each type of management plays a crucial role in ensuring the success and efficiency of an organization.

Management can be categorized into various types based on different criteria. Here are some common types of management:

1. Functional Management:

- Involves grouping activities and people based on their functions or specialized roles, such as marketing, finance, operations, etc.
- Each department has its own manager responsible for overseeing activities within that function.

2. Top-Level Management:

- Also known as strategic or executive management.
- Focuses on setting the overall direction and strategy for the entire organization.
- Includes roles like CEOs, Presidents, and other top executives.

3. Middle-Level Management:

- Responsible for implementing the policies and plans developed by top-level management.
- Acts as a bridge between top-level and lower-level management.
- Includes roles like departmental managers and divisional managers.

4. Front-Line (Supervisory) Management:

- Directly involved in day-to-day operations and supervision of non-managerial employees.
- Ensures that plans and policies are executed effectively.
- Includes roles like supervisors, team leaders, and foremen.

5. Project Management:

- Focuses on planning, executing, and closing projects.
- Involves coordinating resources, managing timelines, and achieving project objectives.

6. Strategic Management:

- Concerned with the overall direction and long-term goals of the organization.
- Involves strategic planning, analysis, and decision-making at the highest level.

7. Human Resource Management (HRM):

- Focuses on managing the organization's workforce.
- Involves recruitment, training, performance appraisal, and employee relations.

8. Financial Management:

- Deals with the financial aspects of the organization.
- Includes budgeting, financial planning, and management of financial resources.

9. Marketing Management:

- Concentrates on promoting and selling products or services.
- Involves market research, advertising, and creating marketing strategies.

10. Operations Management:

- Concerned with designing and controlling the processes of producing goods and services.
- Includes production planning, quality control, and supply chain management.

11. Change Management:

- Focuses on managing organizational change effectively.
- Involves planning, implementing, and monitoring changes to achieve desired outcomes.

12. Crisis Management:

- Involves planning for and responding to unexpected events or crises that may affect the organization.

COOLING SYSTEM IN AUTOMOBILE

8.1 COOLING SYSTEM IN AUTOMOBILE

INTRODUCTION

Internal combustion engines typically convert only 25 to 35 per cent of the chemical energy in the fuel into mechanical energy. Approximately 35 per cent of the generated heat is lost to the cooling medium, with the remainder dissipated through exhaust and lubricating oil.

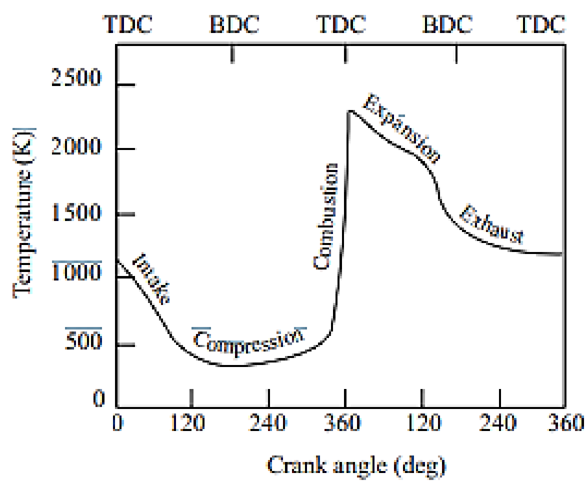
COMBUSTION PROCESS AND TEMPERATURE CONCERNS:

During combustion, the cylinder gas temperature can reach high values, necessitating proper cooling, particularly for the combustion chamber walls. The high temperatures can lead to chemical and physical changes in the lubricating oil, resulting in wear and issues like sticking piston rings, scoring of cylinder walls, or piston seizure.

Excessive cylinder-wall temperatures can elevate the operating temperature of the piston head, adversely affecting piston strength. Overheated cylinder heads may lead to problems like overheated spark plug electrodes causing preignition, potential exhaust valve issues, and the risk of preignition-related engine failure or power loss.

AUTO-IGNITION AND CYLINDER WALL TEMPERATURE

The last part of the charge to burn in spark-ignition (SI) engines is in contact with the combustion space walls during the burning period. High cylinder wall or cylinder head temperatures can lead to auto-ignition. The temperature of gases within the engine cylinder undergoes significant variations across different phases of the cycle. The temperature inside the cylinder is notably at its lowest at the conclusion of the suction stroke. As combustion takes place, there is a swift ascent in temperature, reaching a peak value, only to decrease during the expansion phase. The graphic representation of this gas temperature variation is depicted in Fig illustrating the different processes in the engine cycle.



IMPORTANCE OF TEMPERATURE CONTROL

To ensure correct clearances between engine parts, promote fuel vaporization, maintain optimal oil viscosity, and prevent the condensation of harmful vapors, the inside surface temperature of the cylinder walls should be kept within a specific range. The heat transferred into the combustion chamber walls is continuously removed by employing a cooling system.

Approximately 30 to 35 percent of the total heat supplied by the fuel is removed by the cooling medium, while heat carried away by lubricating oil and heat lost by radiation account for 5 per cent of the total heat supplied. Adequate engine cooling is crucial to prevent engine seizure.

FOLLOWING ARE THE FACTORS GET AFFECTED DUE TO HIGH TEMPERATURE AND HEAT REJECTION:

1.Fuel-Air Ratio:

A modification in the fuel-air ratio induces changes in the temperature of the cylinder gases and influences flame speed. The maximum gas temperature typically occurs at an equivalence ratio of approximately 1.12 (fuel-air ratio around 0.075), resulting in a maximum ΔT. However, experimental observations suggest that the maximum heat rejection occurs for a slightly leaner mixture than this value.

2.Compression Ratio:

An increase in compression ratio leads to a marginal rise in gas temperature near the top dead center. However, due to greater expansion of the gases, a significant reduction in gas temperature occurs near bottom dead center where a large cylinder wall is exposed. The exhaust gas temperature is also lower, resulting in less heat rejected during blowdown. Generally, higher compression ratios tend to marginally reduce heat rejection.

3.Spark Advance:

Deviation from the optimum spark advance—either more or less—increases heat rejection to the cooling system. Spark timing other than the Minimum spark advance for Best Torque (MBT) value reduces power output, leading to increased heat rejection.

4.Preignition and Knocking:

Preignition, akin to advancing ignition timing, may cause erratic running and knocking. Although knocking induces significant changes in local heat transfer conditions, its overall impact on heat transfer seems negligible. Quantitative information regarding the effect of preignition and knocking on engine heat transfer is unavailable.

5.Engine Output:

Engines designed for high mean effective pressures or high piston speeds tend to exhibit lower heat rejection. For the same indicated power, less heat is lost in large engines designed for high performance.

6.Cylinder Wall Temperature:

The average cylinder gas temperature surpasses the cylinder wall temperature significantly. Consequently, marginal changes in cylinder gas temperature have minimal effects on the temperature difference and, consequently, on heat rejection.

NEED FOR COOLING SYSTEM:

In the preceding sections discussing heat rejection, it becomes evident that the conversion of thermal energy to mechanical energy in an engine's cylinders, as a result of the combustion process, generates high temperatures. The combustion gases transfer a substantial portion of this heat to the cylinder head, walls, piston, and valves. Without effective cooling to carry away this excess heat and adequately cool these engine components, damage becomes inevitable.

To safeguard the vital engine components and ensure optimal performance, a cooling system is indispensable. The cooling system serves a dual purpose: preventing damage to crucial parts and maintaining the temperature of these components within specified limits to achieve maximum engine efficiency. Thus, adequate cooling emerges as a fundamental requirement for reciprocating internal combustion engines.

KEY COMPONENT OF COOLING SYSTEM IS OPTIMIZING TEMPERATURE:

The cooling system's primary duty is to strike a delicate balance—preventing the engine from reaching temperatures that could lead to problems while simultaneously allowing it to operate at temperatures ensuring maximum efficiency. In essence, the cooling system aims to keep the engine from becoming excessively hot while avoiding the pitfalls of excessive cooling.

CHARACTERISTICS OF AN EFFICIENT COOLING SYSTEM:

An efficient cooling system possesses two key characteristics crucial for maintaining optimal engine performance:

(i) Effective Heat Removal:

The cooling system should be capable of removing approximately 30% of the heat generated within the combustion chamber. This function is essential to ensure the engine's temperature remains within the optimum range under all operating conditions. Whether the engine is idling, cruising, or under heavy load, the cooling system must efficiently regulate the temperature to prevent overheating and potential damage to engine components.

(ii) Adaptive Heat Removal Rate:

A proficient cooling system should be adaptive to the engine's thermal dynamics. It should be designed to remove heat at an accelerated rate when the engine is operating at elevated temperatures. This capability is crucial for preventing overheating during intense

STEERING SYSTEMS AND STARTING DRIVES

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10.1 STEERING SYSTEM

INTRODUCTION:

The primary function of a steering system is to achieve angular motion of the front wheels, allowing the vehicle to navigate and turn. This is achieved through a steering gear mechanism that converts the rotary motion of the steering wheel into angular motion of the front road wheels.

THE SECONDARY FUNCTIONS OF THE STEERING SYSTEM INCLUDE:

1. Directional Stability:
The steering system is designed to provide directional stability to the vehicle when traveling straight ahead. This ensures that the vehicle maintains a straight path without constant adjustments by the driver.

2. Perfect Steering Condition:
The steering system aims to achieve perfect rolling motion of the road wheels at all times. This ensures smooth and responsive steering, contributing to the overall handling of the vehicle.

3. Straight Ahead Recovery:
After completing a turn, the steering system facilitates the straight ahead recovery of the vehicle. This is essential for a smooth transition from a turned position back to traveling in a straight line.

4. Minimization of Tyre Wear:
The steering system plays a role in minimizing tyre wear by ensuring that the wheels operate smoothly and do not undergo excessive friction or stress during steering maneuvers.

While historically, vehicles were primarily steered by turning the front wheels, recent advancements have introduced all whee lsteering in selected vehicles. However, the conventional front wheel steering system is still widely used.

THE KEY REQUIREMENTS FOR AN EFFECTIVE STEERING SYSTEM INCLUDE:

1. Accuracy and Ease of Handling: The steering mechanism should be accurate and easy to handle, allowing the driver to precisely control the direction of the vehicle.

2. Minimal Effort: The effort required to steer the vehicle should be minimal, ensuring that steering does not become tiresome for the driver, especially during extended periods of driving.

3. Directional Stability: The steering system should contribute to the directional stability of the vehicle, helping it return to a straight head position after completing turns.

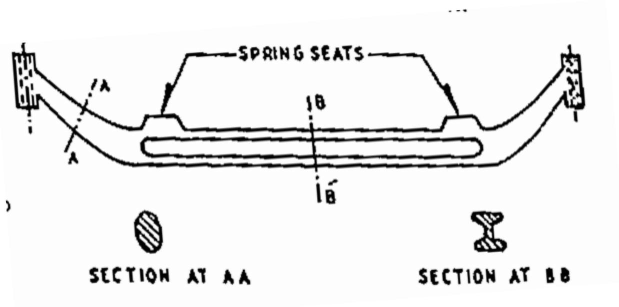
A good steering system is crucial for the overall performance, handling, and safety of a vehicle. It should provide precise control, ease of handling, and contribute to the stability and efficiency of the vehicle's motion.

FRONT AXLE

The front axle in vehicles can be categorized as either a dead axle or a live axle. Traditionally, the front axle was a dead axle, but in modern cars and four wheel drive vehicles, it is often a live axle.

THE DESIGN ELEMENTS OF THE FRONT AXLE

The design elements of the front axle, including the I section construction, choice of end shapes, downward sweep, king pin connection, and mounting of front road wheels, collectively contribute to the axle's strength, stability, and ability to handle torque loads, especially during braking. These features are essential for maintaining optimal performance and safety in the vehicle's steering and braking systems.



THE CONSTRUCTION OF THE FRONT AXLE

Specially in the context of torque loads during braking, involves specific design features:

1. I Section Construction:

Purpose: The central portion of the front axle is constructed in the shape of an I section.

Reason: This I section design is chosen to provide structural strength and stability to the axle.

Load Distribution: The I section is capable of efficiently distributing bending and torque loads, especially those induced during braking.

2. Circular or Elliptical Ends:

Design Variation: The ends of the front axle may have a circular or elliptical shape.

Function: The choice of circular or elliptical ends is influenced by design considerations and the specific load distribution requirements.

Structural Integrity: These end shapes contribute to the overall structural integrity and loadbearing capacity of the axle.

3. Downward Sweep in the Center:

Feature: The central portion of the front axle is designed with a downward sweep.

Purpose: The downward sweep serves the purpose of maintaining a lower chassis height.

Benefits: A lower chassis height can enhance stability and aerodynamics, contributing to better vehicle performance.

4. Connection via King Pins:

Connection Type: The main axle beam is connected to the stub axles using king pins.

Function: King pins facilitate the connection between the main axle beam and the stub axles, allowing for rotational movement.

Steering Mechanism: The king pins are crucial components in the steering mechanism, enabling the front road wheels to turn and maneuver.

5. Front Road Wheels Mounting:

Mounting Points: The front road wheels are mounted on the stub axles.

Steering Link: The stub axles, connected to the main axle beam via king pins, play a key role in the steering system.

RESPONSIVE STEERING:

The connection allows for the responsive turning of the front road wheels in accordance with the steering input.

while dead axles are still used in heavier vehicles, modern cars and four wheel drive vehicles often utilize live axles. The construction and design of live axles are optimized for flexibility, handling bending and torque loads efficiently. The front axle is a critical component that contributes to the overall stability and performance of the vehicle.

1. DEAD AXLE:

Construction: In the case of a dead axle, the front axle beam is typically a drop forging made of steel. This design is more common in heavier vehicles.

Materials: The steel used for dead axles is often 0.4% carbon steel or 1.3% nickel steel.

Use: Dead axles are less common in modern cars but may still be found in heavier vehicles.

2. LIVE AXLE:

Design: The live axle is more prevalent in four wheel drive vehicles and most cars.

Construction: The front axle in live axle systems is designed to be more dynamic and flexible. It can handle both bending loads due to the weight of the vehicle and torque loads generated during wheel braking.

Cross Section: Live axles often have an I section in the central portion, while the ends may be circular or elliptical in shape.

Chassis Height: The central portion of the live axle is typically given a downward sweep to maintain a low chassis height.

Connection: The main axle beam is connected to the stub axles using king pins.

Wheel Mounting: The front road wheels are mounted on the stub axles, providing a connection to the steering mechanism.

3. COMPONENTS OF A FRONT AXLE :

Brake Drum (1): Part of the braking system, the brake drum is connected to the axle and rotates with the wheel.

A. xle Beam (2): The main structural component of the axle that bears the weight and handles bending and torque loads.

RTO AMVI MAINS GUIDE

Comprehensive Notes with MCQ

SECTION-3

- Differential & Rear Axle & Breakes
- Vehicle Maintenance & Transport
- Automobile Electrical & Electronic System
- Introduction to Electric Vehicles
- Motor Vehicle Act & Road Safety

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DIFFERENTIAL AND REAR AXLE AND BRAKES

11.1 DIFFERENTIAL

INTRODUCTION

The differential is a crucial component in the drivetrain of vehicles, especially those with a solid rear axle. When a car takes a turn, the outer wheels need to cover a greater distance than the inner wheels within the same time frame. Without a differential, this situation could lead to skidding, as the wheels would be forced to rotate at the same speed, causing strain on the tires and affecting stability.

The primary function of a differential is to address this disparity in wheel speeds during turns. It achieves this by reducing the speed of the inner wheels and increasing the speed of the outer wheels when the vehicle is turning. At the same time, the differential ensures that all wheels maintain the same speed when the car is moving straight ahead. Essentially, a differential allows for smooth and controlled turning without compromising tire traction.

In the case of non driving wheels, where the wheels are independent of each other, the difference in speeds between inner and outer wheels is not problematic, as these wheels can adjust their speeds independently.

Differentials are not exclusive to two wheel drive vehicles; they are also crucial in many all wheel drive vehicles, including fulltime four wheel drive vehicles. In such setups, differentials are used on each axle, and an additional differential is required between the front and rear axles. This additional differential accommodates the different distances traveled by the front and rear wheels during turns.

However, in part time four wheel drive vehicles, there might not be an additional differential between the front and rear wheels. Instead, the two axles may be locked, causing the front and rear wheels to turn at the same average speed. While this setup eliminates the need for an extra differential, it can result in increased energy loss due to heavy friction at all wheels.

To comprehend the working principle of a differential, one can consider the simplest type known as an open differential. The open differential allows for speed differentiation between the wheels during turns, ensuring a balanced and efficient operation in various driving conditions.

Function of differential:

The differential in a vehicle serves several crucial functions, particularly in situations where the wheels need to rotate at different speeds.

THE PRIMARY FUNCTIONS OF A DIFFERENTIAL AS FOLLOWING :

1. ALLOWING WHEELS TO ROTATE AT DIFFERENT SPEEDS:

The fundamental purpose of a differential is to enable the wheels on the same axle to rotate at different speeds, especially during turns. This is essential because the outer wheel in a turn needs to cover a greater distance than the inner wheel.

2. SMOOTH TURNS:

During a turn, the outer wheel travels a longer distance than the inner wheel. The differential ensures that this speed difference is accommodated, allowing the vehicle to make smooth turns without causing strain on the tires or stressing the drivetrain.

3. POWER DISTRIBUTION:

The differential ensures that power from the engine is distributed to the wheels effectively. It allows the wheels to receive different amounts of torque, which is crucial for maintaining traction and stability in various driving conditions.

4. EQUAL TORQUE DISTRIBUTION:

In a differential, torque is distributed equally between the wheels on the same axle. This ensures that both wheels receive sufficient power, even if they have different traction levels or are on uneven surfaces.

5. PREVENTING WHEEL SKIDDING:

Without a differential, a vehicle might experience wheel skidding during turns, especially if it has a solid rear axle. The differential prevents this by allowing the wheels to rotate at different speeds, reducing the likelihood of skidding.

6. ADAPTABILITY TO TERRAIN:

In off road or challenging terrain situations, differentials play a crucial role in providing traction to the wheels. They allow for independent wheel movement, adapting to uneven surfaces and enhancing the vehicle's ability to navigate various terrains.

7. TORQUE VECTORING:

Some advanced differentials contribute to torque vectoring, actively managing the distribution of torque between individual wheels. Torque vectoring systems enhance vehicle stability, handling, and overall performance during acceleration and cornering.

8. OPTIMIZING FOUR WHEEL DRIVE SYSTEMS:

In four wheel drive (4WD) and all wheel drive (AWD) systems, differentials are essential for distributing power between front and rear axles. This ensures optimal performance and stability in diverse driving conditions.

9. ELECTRONIC STABILITY CONTROL (ESC) INTEGRATION:

Differentials often work in conjunction with electronic stability control systems to prevent skidding and improve overall vehicle stability. This integration enhances safety during sudden maneuvers or challenging driving conditions.

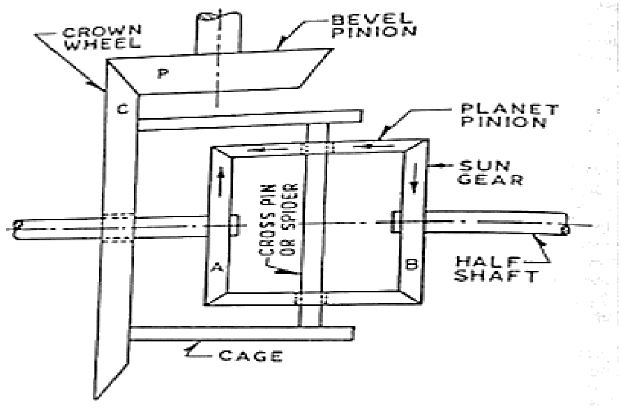
10. Reduction of Stress on Tires and Components:

By allowing the wheels to rotate at different speeds, differentials reduce stress on tires and various drivetrain components. This contributes to increased longevity and reduced wear on these components.

DIFFERENTIAL COMPONENTS:

The components of differential work in tandem to enable the differential to distribute torque and manage speed differentials, providing stability and smooth operation during turns and diverse road conditions

The differential comprises several key components, each playing a crucial role in its operation:



Principle of differential.

CROWN WHEEL:

The crown wheel is a large gear attached to the final drive of the vehicle's axle. It provides the rotational connection between the differential and the axle assembly.

CAGE WITH CROSS PIN OR SPIDER:

Connected to the crown wheel, a cage holds either a 'crosspin' or a 'spider,' depending on the number of planet pinions employed in the differential mechanism.

In cases with two planet pinions, a cross pin is used. For differentials with four planet pinions, a spider is employed.

SUN GEARS AND PLANET PINIONS:

Two sun gears are part of the differential setup, meshing with the corresponding planet pinions.

The number of planet pinions varies; it can be either two or four, depending on the specific design.

AXLE HALF SHAFTS:

Axle half shafts are connected to each sun gear, ensuring a direct link between the differential and the wheels.

These half shafts transmit the rotational motion from the differential to the wheels, allowing them to turn at different speeds during various driving conditions.

WORKING OF A DIFFERENTIAL:

The differential is a crucial component in the drivetrain of a vehicle, providing a way to compensate for differences in wheel speeds during turns.

INTRODUCTION TO ELECTRIC VEHICLES

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14.1 EVOLUTION OF ELECTRIC VEHICLE'S

INTRODUCTION

Explore the origins of electric vehicles, dating back to the 19th century. Discuss early inventors and their contributions, such as Thomas Davenport and Robert Anderson. Highlight the initial applications of electric vehicles, focusing on the limitations and challenges faced during this period.

Delve into the obstacles and drawbacks that hindered the widespread adoption of electric vehicles in the past. Discuss issues like limited range, battery technology constraints, and the competition with internal combustion engines. Explain how these challenges have been gradually overcome through technological advancements.

Highlight key milestones in the development of electric vehicles. Discuss breakthrough moments, technological innovations, and significant achievements that have shaped the evolution of electric transportation. Include important events and advancements up to the present day.

Basic Components:

Provide a detailed explanation of the fundamental components of electric vehicles. Discuss the role of the electric motor, the battery pack, and the power electronics. Explain how these elements work together to propel the vehicle and how advancements in technology have improved their efficiency.

TYPES OF ELECTRIC VEHICLES:

Differentiate between Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PHEVs), and Hybrid Electric Vehicles (HEVs). Explain the characteristics and advantages of each type, providing insights into the diverse options available to consumers.

CHARGING INFRASTRUCTURE:

Explore the critical role of charging infrastructure in supporting the widespread adoption of electric vehicles. Discuss different charging options, such as home charging, public charging stations, and fast-charging networks. Address the evolution of charging technology and its impact on the convenience and accessibility of electric vehicles.

ENVIRONMENTAL IMPACT:

Reducing Carbon Footprint:

Examine how electric vehicles contribute to reducing greenhouse gas emissions compared to traditional internal combustion engine vehicles. Provide data and studies showcasing the environmental benefits of electric transportation in terms of lower carbon dioxide emissions.

Life Cycle Analysis:

Conduct a life cycle analysis of electric vehicles, considering factors from manufacturing to end-of-life disposal. Discuss the environmental impact at each stage and compare it with conventional vehicles. Highlight efforts by manufacturers to minimize the ecological footprint of electric vehicles.

Sustainability in EV Production:

Explore sustainable practices in the production of electric vehicles. Discuss eco-friendly materials, energy-efficient manufacturing processes, and the recycling of components. Showcase industry initiatives and innovations aimed at making electric vehicle production more environmentally sustainable.

ADVANCEMENTS IN ELECTRIC VEHICLE TECHNOLOGY

1 Battery Technology:

Provide an in-depth look at the latest advancements in battery technology. Discuss improvements in energy density, charging speed, and battery longevity. Explore ongoing research and development in the quest for more efficient and cost-effective battery solutions.

2 Autonomous Driving and Connectivity:

Examine the integration of electric vehicles with autonomous driving technology. Discuss how connectivity features enhance the driving experience, improve safety, and contribute to the overall appeal of electric vehicles.

.3 Innovations in Design:

Highlight innovative design features that distinguish electric vehicles from traditional counterparts. Discuss aerodynamics, lightweight materials, and futuristic aesthetics. Explore how design innovations contribute to the efficiency and attractiveness of electric vehicles.

CHALLENGES AND SOLUTIONS

1 RANGE ANXIETY:

Address one of the common concerns associated with electric vehicles – range anxiety. Discuss the factors contributing to range anxiety, technological advancements mitigating this issue, and strategies for overcoming consumer apprehensions.

2 INFRASTRUCTURE DEVELOPMENT:

Examine the challenges and progress in developing a robust charging infrastructure. Discuss the importance of government initiatives, private investments, and international collaborations in expanding and improving the electric vehicle charging network.

3 POLICY AND REGULATION:

Explore the role of government policies and regulations in shaping the electric vehicle market. Discuss incentives, subsidies, emission standards, and other regulatory measures that influence the adoption and growth of electric vehicles globally.

THE FUTURE OF ELECTRIC VEHICLES

Explore the latest trends shaping the electric vehicle industry. Discuss new models, technological advancements, and consumer preferences that are driving innovation. Highlight the role of startups, established automakers, and the broader ecosystem in shaping the future of electric transportation.

GLOBAL ADOPTION AND IMPACT:

Examine the global adoption of electric vehicles and its impact on the automotive industry. Discuss regional variations, market trends, and the geopolitical factors influencing the growth of electric vehicles. Explore how the shift to electric transportation is influencing energy markets and infrastructure development.

CHALLENGES AND OPPORTUNITIES AHEAD:

Discuss the challenges and opportunities that lie ahead for the electric vehicle market. Address issues such as technological barriers, market competition, and geopolitical factors. Explore potential breakthroughs, collaborations, and future developments that could shape the trajectory of electric vehicles.

MULTIPLE CHOICE QUESTIONS

1. Who is credited as one of the earliest inventors of electric vehicles in the 19th century?
A. Thomas Edison
B. Nikola Tesla
C. Thomas Davenport
D. Henry Ford

2. What were some of the early applications of electric vehicles primarily used for?
A. Long-distance travel
B. Urban transportation and delivery services
C. Military operations
D. Agricultural machinery

3. What were some of the limitations faced by early electric vehicles?
A. Limited range and battery technology constraints
B. Excessive noise and emissions
C. High manufacturing costs
D. Limited availability of charging stations

4. Which technological advancement played a crucial role in overcoming early obstacles to electric vehicle adoption?
A. Development of more efficient engines
B. Introduction of lightweight materials
C. Improvement in battery technology
D. Implementation of autonomous driving features

5. What event marked a significant milestone in the development of electric vehicles in recent history?
A. Invention of the internal combustion engine
B. Launch of Tesla Roadster
C. Introduction of hybrid electric vehicles
D. Implementation of fast-charging networks