UNIT 1

By STUCOR

1. **Explain the various contributions of civil engineers to the welfare of the society?**
   1. Civil engineer will work on planning, design, construction and maintenance of projects such as roads, buildings, dams, bridges, sewages and water supply systems.
   2. Civil engineering is about community service, development, and improvement.
   3. Civil engineers often use theory and models to predict how a design will perform.
   4. Civil engineers test their ideas on field without endangering life.
   5. Civil engineers develop infrastructure for the society which is the backbone of the society.
   6. Civil engineers increase the health and quality of life by developing better water supply, sewage systems, and waste water plants, to protect from natural hazards and provide health care.
   7. Civil engineers improve agriculture through water management systems and distribution projects.
   8. Civil engineers provide solution for the rapid and dramatic changes of transportation.
   9. Structural engineers deals with connections design, analysis and construction of components to resist loads from internal and external forces.
   10. As a structural engineer, you will face the challenge of analyzing and designing structures to ensure that they safely perform their purpose.
   11. They must support their own weight and resist dynamic environmental loads such as hurricanes, earthquakes, blizzards, and floods.
   12. Stadiums, arenas, skyscrapers, offshore oil structures, space platforms, amusement park rides, bridges, office buildings, and homes are a few of the many types of projects in which structural engineers are involved
   13. Structural engineers develop new materials other than steel and cements which with stand more loads & have high strength by weight ratio which includes FRP, polymers, etc,.
   14. Geotechnical engineers apply the knowledge about the behavior of soils and its composition for design of Foundations, retaining walls, earth dams, clay liners and geo synthetics for waste condiments.
   15. Examples of facilities in the earth are tunnels, deep foundations, and pipelines. Highway pavements and many buildings are supported on the earth.
   16. Certain important goals of geotechnical engineering include
       1. Design of foundation 2.design temporary/permanent excavations 3.landfill disposal of waste. 4. Ground water contamination
   17. Transportation plays and essential role in the development of the society by providing trade routes and harbors air routes etc,.
   18. Civil engineers plan, design, built, operate and maintain these of transport.
   19. Civil engineers provide safe, efficient and convenient movement of people and goods
   20. Civil engineers consider the forces and movements, weight and stress of the vehicles in motion and centrifugal forces at curves while the design the transportation.
   21. The collection, storage, treatment, transmission and distribution of water played a significant role in urbanization, population growth and commercial agriculture and land use.
   22. Clean, potable water piped from a far led to the development of such large cities as Las Vegas, and the suburban areas around Chicago and Los Angeles.
   23. During the 20th century, water supply and distribution systems have led to an increase in life expectancy, reduction in infant mortality and morbidity, and improvements in environmental quality in developed countries.

2. **What are the ROLE OF CIVIL ENGINEERS**

A civil engineer has to conceive, plan, estimate, get approval, create and maintain all civil engineering activities.

Civil engineer has very important role in the development of the following infrastructure:

1. Measure and map the earth's surface.
2. Plan new townships and extension of existing towns.
3. Build the suitable structures for the rural and urban areas for various utilities.
4. Build tanks and dams to exploit water resources.
5. Build river navigation and flood control projects.
6. Build canals and distributaries to take water to agricultural fields.
7. Purify and supply water to the needy areas like houses, schools, offices etc.
8. Provide and maintain communication systems like roads, railways, harbors and airports.
9. Devise systems for control and efficient flow of traffic.
10. Provide and maintain solid and waste water disposal system.
11. Monitor land, water and air pollution and take measures to control them. Fast growing industrialization has put
    heavy responsibilities on civil engineers to preserve and protect environment.

3. Briefly explain sub divisions of civil engineering and their scope.

Structural Engineering.

Before building a structure, it should be analysed and designed to decide about its size to resist the possible forces coming on it.

The structure should be safe and at the same time its components should be as small as possible.

Need of tall structures and improvements in computers gave rise to matrix method and finite element method of analysis.

Disasters due to earthquakes have made civil engineers to study earthquake forces and build earthquake resistant structures.

It needs the knowledge of structural dynamics.

A civil engineer has to not only give a safe structure but he has to give an economical structure also. Hence, there is need for studying mathematical optimisation techniques.

All these aspects of analysis and design fall under structural engineering field.

Geotechnical Engineering.

All structures have to finally transfer the load acting on them to soil safely.

Soil property changes from place to place. Even in the same place it may not be uniform at different depth and in different seasons.

Hence, a civil engineer has to properly investigate soil and decide about the safe load that can be spread on the soil. This branch of study in civil engineering is known as geotechnical engineering.

Apart from finding safe bearing capacity for foundation of buildings, geotechnical engineering involves various studies required for the design of pavements, tunnels, earthen dam, canals and earth retaining structures.

It involves study of ground improvement techniques also.

Hydraulics, Water Resources and Irrigation Engineering.

Water is an important need for all living beings. Study of mechanics of water and its flow characteristics is another important field in civil engineering and it is known as hydraulics.

Requirement of water in cities for domestic purpose and for industries is continuously increasing. Rural areas need water for agricultural field also. Hence civil engineers have to look for new water resources and for storing them. This branch of civil engineering is known as water resources engineering.

Water stored in reservoirs by building bunds and dams should be brought to agricultural fields through canals and distributories. Study connected with this aspect is known as irrigation engineering.

Water Supply and Sanitary Engineering.

When water is required for drinking purpose it should be purified and made potable. Purification of water and the technology involved in taking it to the houses is known as water supply engineering.

Waste waster and solid waste should be treated and disposed so that they do not create health hazard. This branch of civil engineering is known as sanitary engineering.

Environmental Engineering.

Apart from tackling solid and waste water disposal civil engineers have to tackle air pollution problem also.

Due to industrialization air pollution is becoming a major problem.

It is estimated that for every tonne of cement produced one tonne of CO_2 is released to environment.

Vehicles also produce lot of CO_2.

During the last one century, the environmental pollution has resulted in global warming by 4°C.

An environmental disaster will be unavoidable if China, India and other developing countries start consuming as much energy and materials as the West did it in its march to industrialization.

Hence environmental engineering is emerging as an important field of study in civil engineering.

Transportation Engineering.

Transportation facility is another important need. Providing good and economical road links is an important duty of civil engineers.

It involves design and construction of base courses, suitable, surface finishes, cross drainage works, intersections, culverts, bridges and tunnels etc.

Railways is another important long-way transport facility.

Design, construction and maintenance of railway lines are parts of transportation engineering.

Globalization has resulted into requirement of airports and harbors.

For proper planning of these transport facilities, traffic survey is to be carried out.

Carrying out traffic survey and then planning, designing, construction and maintenance of roads, railways, bridges, tunnels, airports and harbors is known as transportation engineering.

Town Planning and Architecture.

With the growth of population and industries new towns are coming up and existing ones are growing. Proper town planning is to be made by civil engineers. Structures should be aesthetically good also. Architecture covers this area. This field of civil engineering has grown up so much that it has become a separate branch of engineeing.

Surveying.

For planning all developmental activities, proper maps are required. The science of map making is known as surveying.

Survey maps provide the relative positions of various objects of the area in the horizontal as well as vertical directions.

Earlier conventional instruments like chain, tape, compasses, theodolites and levels were used for various measurements in surveying.

In this electronic era the modern equipments like electronic distance meters and total stations are used for measurements.

Modern technology like remote sensing has made surveying vast area in a short period possible.

4. Write short note on impact of infrastructure development on the economy of the country.

Civil engineering activities in the infrastructural development are:

(*i*) Good planning of towns and extension areas in the cities. Each extension area should be self sufficient in accommodating offices, educational institutions, markets, hospitals, recreational facilities and residential accommodation.

(*ii*) Assured water supply. (*iii*) A good drainage system.

(*iv*) Pollution free environmental conditions.

(*v*) A well planned and built network of roads and road crossings. (*vi*) Railways connections to all important cities and towns.

(*vii*) Airports and harbours of national and international standards.

Infrastructure also involves electricity supply, without assured electric supply no city town can develop. Internet and telephones are also desirable features.

Educational facility also forms part of infrastructure. Proximity of good primary and secondary schools to residential areas is desirable. Collegiate and professional education also form part of infrastructure of a city.

Good health care facility is a necessity. Primary health centres, specialised hospitals and doctors add to the desirable infrastructure facility.

Effect of infrastructure facilities are:

1. Connecting producing centres to marketing places minimise exploitation of producers by middlemen.

Imports and exports became easy and as a result of which whole world becomes a village.

2. Improved irrigation facility enhances agricultural products and hence producers as well as consumers are benefitted.

3. Infrastructural facility develops scope for a number of industries and it creates job opportunities.

4. Improved education and health care give rise to skilled and healthy work force. Quality of life of the people is improved.

5. Utilisation of manpower for the benefit of mankind brings down antisocial activities.

6. In case of natural calamities assistance can be easily extended to the affected areas and misery of affected people minimised.

7. Infrastructural facility imporves defence system and peace exists in the country.

8. Improved economical power of the country brings a respectable status in the world.

The world has realised that a government should not involve itself in production and distribution but should develop infrastructure to create an atmosphere for economical development.

SCOPE OF MECHANICAL ENGINEERING

1.Explain the contribution of mechanical engineering to the welfare of the society.

Mechanical engineering is the discipline that applies engineering physics and material sciences principles to design,analyse,manufacture and maintain mechanical system.

Various disciplines of Mechanical engineering

1.Applied mechanics 2.Dynamics 3.Fluid Mechanics 4.Thermodynamics 5.Heat transfer 6.Production Technology

Fields of employment :

1.Technology 2.Science 3.Exploration 4.Military

contribution of mechanical engineering to the welfare of the society.

1.The energy solution. Society of today badly needs more power. We have huge shortage of electricity, especially in underdeveloped countries. Prices of fuel oil are going up. As a Mechanical engineer you need to find a green way to generate power.

2. The transportation solution. Millions of people die every year while traveling. Safety has to be priority while designing new vehicles.

3. Cost effective products. There are many who can't afford to buy basic things that are required for day to day living. You need find better machines and processes that will reduce prices.

4. And above all society wants you to be the leader. You shall bring the change society needs. Society doesn't know what she wants. She knows how to choose. It's your duty to give her better options.

Mechanical engineering covers development and implementation of solutions to energy and water needs of the society with minimal environmental impact.

Mechanical engineers contribute to the society by designing, manufacturing and maintaining mechanical devices for broad range of applications in all forms of industry.

Mechanical engineers also develops materials and measurements that contributes to research, economic and management dimensions that support the industrial activities.

Mechanical engineering principles are employed in wide range of industries such as power generation, manufacturing, energy repair and maintanence,automation and control robotoics,electronics,nano technolog,food industries,petroleum,aero space,etc,.

Specialized sub divisions in mechanical engineering

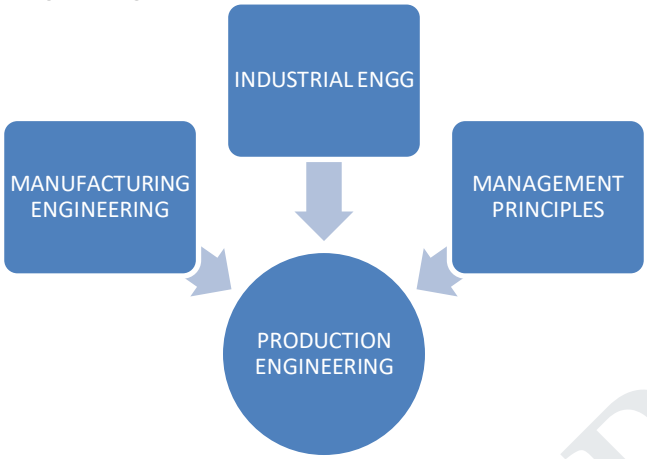
1.Production engg.2.Automobile engg. 3.Energy engg.

Production engineering:

It is the combination of manufacturing technology, engineering sciences with material sciences. It has a wide range of engineering practices and it is aware of management challenges related to production.

Goals of production engineering are to accomplish the production process in the smoothest, most effective and economic way.

It comprises of the application of casting, machining process, joining process, metal cutting, tool design, automation jigs, die and mold design, design of machine tools, automation.



Manufacturing or Production Engineering

Manufacturing or Production Engineering is the subset / specialization of a Mechanical Engineering. Mechanical Engineering with the focus only on Machine Tools, Materials Science, Tribology, and Quality Control is known as Manufacturing Engineering. Professional manufacturing engineers are responsible for all aspect of the design, development, implementation, operation and management of manufacturing system. Manufacturing is the most important element in any engineering process & Manufacturing Engineers are key personnel in many organization. The manufactured products range from aero planes, turbines, engines and pumps - to integrated circuits and robotic equipment.

What does a Production Engineer do?

Production Engineers work towards Choosing machinery and equipments for the particular manufacturing process

- Production Engineers will be planning & scheduling the production in any manufacturing industry. [e.g. Automobile Manufacturing industry].
- Production Engineers will be programming the CNC machines to produce engineering components such as gears, screws, bolts, etc
- They are responsible for quality control, distribution and inventory control.

Production Engineer Responsibilities and Duties

- Plan and coordinate production engineering processes on daily basis to produce high quality products.
- Develop process improvements to effectively utilize equipment and materials to maximize production.
- Develop operational strategies to achieve production and financial objectives.
- Identify unsafe operations and practices and report the same to Manager immediately.
- Establish safety procedures and environmental regulations for employees.
- Provide engineering support for production and maintenance activities to ensure maximum production.
- Perform engineering analysis to reduce downtime and outages.
- Evaluate current production activities and make recommendations for improvements.
- Implement cost reduction initiatives while maintaining high quality standards.
- Develop operating instructions and equipment specifications for production activities.
- Provides training and guidance to team members to accomplish production goals.

- Stay current with product specifications, engineering technology and production processes.
- Develop best practices to improve production capacity, quality and reliability.
- Investigate problems, analyze root causes and derive resolutions.
- Aid in budget preparation and monitor expenses and profitability.

Energy Engineering:

It is the field of engineering dealing with energy efficiency services, facility management, plant engineering, environmental compliance and alternative energy technology.

It is the most recent engineering discipline.

Combines the knowledge from the field of physics, chemistry, mathematics with economic and environmental engineering practices. Energy engineers apply their skills to increase efficiency and further develop renewable sources of energy.
Main job is to find the most efficient and sustainable way to operate buildings and manufacturing processes.
Energy engineers audits the use of energy in those processes and suggests ways to improve the systems.

Advanced lighting, Better insulation, efficient heating and cooling properties of buildings.

1. Hydro 2.Solar 3.Bio-mass 4.Geo thermal 5.ONGE

Responsibilities:

1. You will be need to Design, develop and built renewable energy technologies.
2. Combine renewable energy pattern with existing power systems.
3. Arrange new supplies and negotiate traffic with fuel provider
4. Carry out site inspection and energy surveys
5. Design and select equipments.
6. Use mathematical and computer model to complete design and specification calculations
7. Carry out lab experiments and adapt them to the large scale
8. Prepare detail schedule of work, feasibility studies and cost estimates
9. Check site and ground conditions for the installation of renewable technologies such as wind turbines.
10. Keep up dates with legislation and environmental standards
11. Develop technical expertise in all matters.

Skills for mechanical engineers:

1. Responsible for the safe and efficient operation of internal combustion engines, steam and gas turbines.
2. Investigate equipment failures and difficulties to diagnose faulty operation and make recommendation to maintenance crew.
3. Assist drafters: CADD or drafting equipment and software.
4. Provide feedback to design engineer on customer problems and needs.
5. Oversee the installation,operation,maintanence and repair of machines and equipments to ensure they are installed and functioning according to specification.

APPLICATION:

1.Modern electric, wireless, Nuclear technology and tesla coil which has seen widely used in radio, television sets and other electronic equipment.
2. GPS, dynamic, flight simulations.
3. Steam engine, rotary engine and copying system
4. Heat pump, steam & gas turbines
5. Aerodynamics.

ENERGY ENGG:

Energy engineering or **energy** systems **engineering** is a broad field of **engineering** dealing with **energy** efficiency, **energy** services, facility management, plant **engineering**, environmental compliance and alternative **energy** technologies. ... **Energy engineers** are also employed by the fields of oil and natural gas extraction.

We divide our **energy use** among four economic sectors: residential, commercial, transportation, and industrial. Heating and cooling our homes, lighting office buildings, driving cars and moving freight, and manufacturing the products we rely on in our daily lives are all functions that require **energy**.

Energy systems engineers oversee complex **energy** conversion and distribution**systems**, work to improve **energy** storage **systems**, and manage the efficient use of **energy** in building, manufacturing, and processing **systems**. ... Assess the environmental impact of alternative **energy systems**.

As an **energy engineer**, you'll be involved with the production of **energy** through natural resources, such as the extraction of oil and gas, as well as from renewable or sustainable sources of **energy**, including biofuels, hydro, wind and solar power.

Thermal Engineering is controlling heating or cooling processes in an enclosed environment or an open environment using various equipments. It involves the science of thermodynamics, fluid mechanics, heat and mass transfer.

Applications:

The most common example is **air conditioning**(Home & car). You need extensive knowledge of thermal engineering for designing a compressor/condenser/evaporator coil/insulation used in any air conditioning unit. Refrigerators too use the same principles. Well to be frank it can be used in 'n' number of ways like we utilize thermal energy for generation of electricity, for heating purposes (it can be water heating, space heating, etc.), refrigeration system (vapour absorption types), etc.

The most important application & perhaps one of the greatest machines which ushered the industrial revolution is a **BOILER**. *This my friend is used in every coal, gas, oil & nuclear power plant on the planet*. Basically a boiler generates a lot of heat by burning coal/gas/oil which is absorbed by water & steam is formed, which is later expanded through a steam turbine to generate *electricity*. The nuclear powered submarine or aircraft carrier use these boilers too!

Another important application is **COMBUSTION ENGINES**. Look at the image below to see the wonder of thermal engineering - **A V8 ENGINE!!** I don't need to tell you how important this piece of machinery is to mankind.

The thermal systems engineering refers to how energy is used in every areas of our lives and those systems always include the transfer, storage and conversion of energy. Some examples are:

Engines (For cars, ships, boats, airplanes, rockets, helicopters, trains, motorcycles and so on)
Freezers
Microwaves
Power generating plants

AUTOMOBILE ENGINEERING

It is a part of mechanics through the application of automotive technology, the course offers specialization in vehicle designing, repairing, testing & assembling. Also learn safety engg, Quality management & automotive analysis as well as assembling & installation of various automobile, aerospace & machine.

INTRODUCTION :

Automobile engineering is the one of the stream of mechanical engineering. It deals with the various types of automobiles, their mechanism of transmission systems and its applications. Automobiles are the different types of vehicles used for transportation of passengers, goods, etc. Basically all the types of vehicles works on the principle of internal combustion processes or sometimes the engines are called as internal combustion engines. Different types of fuels are burnt inside the cylinder at higher temperature to get the transmission motion in the vehicles. Most of the automobiles are internal combustion engines vehicles only. Therefore, every mechanical and automobile engineer should have the knowledge of automobile engineering its mechanism and its various applications.

DEFINITION: Automobile engineering is a branch of engineering which deals with everything about automobiles and practices to propel them. Automobile is a vehicle driven by an internal combustion engine and it is used for transportation of passengers and goods on the ground. Automobile can also be defined as a vehicle which can move by itself. Examples : Car, jeep, bus, truck, scooter, etc.

CLASSIFICATION OF VEHICLES:

Automobiles or vehicles can be classified on different bases as given below :

On the Basis of Load : (a) Heavy transport vehicle (HTV) or heavy motor vehicle (HMV), e.g. trucks, buses, etc. (b) Light transport vehicle (LTV) e.g. pickup, station wagon, etc. (c) Light motor vehicle (LMV), e.g. cars, jeeps, etc.

On the Basis of Wheels : (a) Two wheeler vehicle, for example : Scooter, motorcycle, scooty, etc. (b) Three wheeler vehicle, for example : Auto rickshaw, three wheeler scooter and tempo, etc. (c) Four wheeler vehicle, for example : Car, jeep, trucks, buses, etc. (d) Six wheeler vehicle, for example : Big trucks with two gear axles each having four wheels.

On the Basis of Fuel Used (a) Petrol vehicle, e.g. motorcycle, scooter, cars, etc. (b) Diesel vehicle, e.g. trucks, buses, etc. (c) Electric vehicle, e.g. battery drive (d) Steam vehicle, e.g. an engine which uses steam. (e) Gas vehicle, e.g. LPG and CNG vehicles, where LPG is liquefied petroleum gas and CNG is compressed natural gas.

On the Basis of Body On the basis of body, the vehicles are classified as : (a) Sedan with two doors (b) Sedan with four doors (c) Station wagon (d) Convertible, e.g. jeep, etc. (e) Van (f) Special purpose vehicle, e.g. ambulance, milk van, etc. Transmission (a) Conventional vehicles with manual transmission, e.g. car with 5 gears. (b) Semi-automatic (c) Automatic: In automatic transmission, gears are not required to be changed manually. It is automatically changes as per speed of the automobile.

Position of Engine in Front : Most of the vehicles have engine in the front. Example: most of the cars, buses, trucks in India.

Engine in the Rear Side: Very few vehicles have engine located in the rear. Example: Nano car.

COMPONENTS OF THE AUTOMOBILE

The automobile can be considered to consist of five basic components: (a) The Engine or Power Plant : It is source of power. (b) The Frame and Chassis: It supports the engine, wheels, body, braking system, steering, etc. (c) The transmission which transmits power from the engine to the car wheels. It consists of clutch, transmission, shaft, axles and differential. (d) The body fitted on chassis. (e) Accessories including light, air conditioner/hearer, stereo, wiper, etc.

FUNCTIONS OF MAJOR COMPONENTS OF AN AUTOMOBILE Chassis and Frame:

The chassis is formed by the frame with the frame side members and cross members. The frame is usually made of box, tubular and channel members that are welded or riveted together. In addition to this, it comprises of the springs with the axles and wheels, the steering system and the brakes, the fuel tank, the exhaust system, the radiator, the battery and other accessories. Along with this the frame supports the body. Engine or Power Plant : The engine is the power plant of the vehicle. In general, internal combustion engine with petrol or diesel fuel is used to run a vehicle.

An engine may be either a two-stroke engine or a four-stroke engine. An engine consists of a cylinder, piston, valves, valve operating mechanism, carburetor (or MPFI in modern cars), fan, fuel feed pump and oil pump, etc. Besides this, an engine requires ignition system for burning fuel in the engine cylinder.

Transmission System (Clutch and Gear Box): The power developed by the engine is transferred to the wheels by transmission system. Transmission system must do three jobs : (a) It must provide varying gear ratios. Number of gear ratio are equal to number of gears in a vehicle. (b) It must provide a reverse gear for moving vehicle in reverse direction. (c) It must provide a neutral or disconnecting arrangement so that the engine can be uncoupled from the wheels of the vehicle. In a conventional transmission system, there is a clutch, a manually operated transmission (gear box), a propeller shaft and a differential or final drive.

Clutch : The purpose of the clutch is to allow the driver to couple or decouple the engine and transmission. When clutch is in engaged position, the engine power flows to the transmission through it (clutch). When gears are to be changed while vehicle is running, the clutch permits temporary decoupling of engine and wheels so that gears can be shifted. In a scooter, the clutch is operated by hand where as in a car the clutch is operated by foot. It is necessary to interrupt the flow of power before gears are changed. Without a clutch, it will by very difficult. Final Drive Final drive is the last stage in transferring power from engine to wheels. It reduces the

speed of the propeller shaft (drive shaft) to that of wheels. It also turns the drive of the propeller shaft by an angle of 90 degree to drive the wheels.

The propeller shaft has a small bevel pinion which meshes with crown wheel. The crown wheel gives rotary motion to rear axles. The size of crown wheel in bigger than that of bevel pinion, therefore, the speed of rear axles (or crown wheel) in lower than the speed of pinion. Final drive is of two types, i.e. chain type and gear type. Braking System Brakes are used to slow down or stop the vehicle.

Hydraulic brakes are generally used in automobiles, where brakes are applied by pressure on a fluid. Mechanical brakes are also used in some vehicles. These brakes are operated by means of leavers, linkages, pedals, cams, etc. Hand brake or parking brake is known usually mechanical brake. These are used for parking the vehicles on sloppy surfaces and also in case of emergency.

Gear Box : Gear box contain gearing arrangement to get different speeds. Gears are used to get more than one speed ratios. When both mating gears have same number of teeth, both will rotate at same number speed. But when one gear has less teeth than other, the gear with less number of teeth will rotate faster than larger gear. In a typical car, there may be six gears including one reverse gear. First gear gives low speed but high torque. Higher gears give progressively increasing speeds. Gears are engaged and disengaged by a shift lever.

Steering System : In front wheels can be turned to left and right by steering system so that the vehicle can be steered. The steering wheel is placed in front of driver. It is mechanically linked to the wheels to provide the steering control. The primary function of the steering system is to provide angular motion to front wheels so that vehicle can negotiate a turn. It also provides directional stability to vehicle when the vehicle moves ahead in straight line. Now-a-days, many vehicles are equipped with power steering which uses pressure of a fluid to reduce steering effort. When driver turns the steering wheel, a hydraulic mechanism comes into play to provide most of the effort needed to turn the wheel. Front Axle A part of the weight of vehicle is transmitted to the wheels through this axle. The front axle performs several functions. It carries the weight of the front of the vehicle and also takes horizontal and vertical loads when vehicle moves on bumpy roads. When brakes are provided on front wheels, it endures bending stresses and tensional stresses. It is generally made from steel drop forging. It is robust in construction. Suspension System Suspension system of an automobile separates the wheel and axle assembly of the automobile from its body. Main function of the suspension system is to isolate the body of the vehicle from shocks and vibrations generated due to irregularities on the surface of roads. Shock absorbers are provided in the vehicles for this purpose. It is in the form of spring and damper. The suspension system is provided both on front end and rear end of the vehicle**.**

A suspension system also maintains the stability of the vehicle in pitching or rolling when vehicle is in motion.

APPLICATION OF I. C. ENGINE :

Road vehicles * Aircraft * Locomotive * Construction Equipment Pumping set * several Industries Small Two Stroke Petrol Engine : Used when operation is simple and requirement of low cost of prime mover (scooters, pumping sets etc.) Small Four Stroke Petrol Engine : Used in automobiles, generators, pumping set. Two Stroke Diesel Engine : High power, generally used in ship propulsion. Four Stroke Diesel Engine : Mostly used engine, have diameter 50 to 600 mm, speed ranges from 100 to 4400 rpm, power developed is 1 to 1000 kW. Used in pumping sets, construction machinery, drilling rigs, tractors, diesel electric locomotive, mobile & stationary electric generation plants.

Engineering design

Why is the engineering design process important?

The **engineering design process** is a series of steps that engineers follow when they are trying to solve a problem and **design** a solution for something; it is a methodical approach to problem solving. This is similar to the "Scientific Method" which is taught to young scientists.

Job Duties

It is important that product design engineers be familiar with, and adhere to, their company's product standards and specifications, so that they may design quality products that represent the company brand. They must also keep trends and the needs of consumers in mind when designing products. Product design engineers may also be responsible for making improvements or updates to existing design and development standards. Professionals may also need to understand how their decisions affect product cost, performance, and quality.

"Scientists discover the world that exists; engineers create the world that never was."

Theodore von Karman, co-founder of NASA's Jet Propulsion Laboratory

INDUSTRIAL ENGINEERING

Industrial engineering is a branch of **engineering** which deals with the optimization of complex processes, systems, or organizations. **Industrial engineers** work to eliminate waste of time, money, materials, person-hours, machine time, energy and other resources that do not generate value.

Industrial designers develop concepts and designs for manufactured products. They typically specialize in one product category, such as automobiles, furniture or housewares. They must be imaginative and persistent to communicate their ideas about new product **design**.

Industrial engineering is a branch of engineering which deals with the optimization of complex processes, systems, or organizations. Industrial engineers work to eliminate waste of time, money, materials, person-hours, machine time, energy and other resources that do not generate value.

CAD/CAM/CIM:

computer manufacturing aided design. **CAD** is particularly valuable in space programs, where many unknown design variables are involved. ... **CIM** is a programmable manufacturing method designed to link **CAD**, **CAM**, industrial robotics, and machine manufacturing using unattended processing workstations.

CAM is now a system **used** in schools and lower educational purposes. **CAM** is a subsequent computer-aided process after computer-aided design (CAD) and sometimes computer-aided engineering (CAE), as the model generated in CAD and verified in CAE can be input into **CAM** software, which then controls the machine tool.

CAD/**CAM** applications are used to both design a product and program manufacturing processes, specifically, CNC machining. **CAM software** uses the models and assemblies created in **CAD software** to generate toolpaths that drive machine tools to turn designs into physical parts.

Computer integrated manufacturing (CIM), a term popularized by Joseph Harrington in 1975, is also known as autofacturing. CIM is a programmable manufacturing method designed to link CAD, CAM, industrial robotics, and machine manufacturing using unattended processing workstations. CIM offers uninterrupted operation from raw materials to finished product, with the added benefits of quality assurance and automated assembly.

UNIT 2

BY STUCOR

Unit II

Surveying:

It is defined as the process of measuring horizontal distances, vertical distances and included angles to determine the location of points on, above or below the earth surfaces.

The term surveying is the representation of surface features in a horizontal plane.

The process of determining the relative heights in the vertical plane is referred as levelling.

Objectives of Surveying:

The data obtained by surveying are used to prepare the plan or map showing the ground features.

When the area surveyed is small and the scale to which its result plotted is large, then it is known as Plan

When the area surveyed is large and the scale to which its result plotted is small, then it is called as a Map

Setting out of any engineering work like buildings, roads, railway tracks, bridges and dams involves surveying

Main divisions of surveying:

Types of Surveying

Plane surveying

Geodetic surveying

Concept:

Since the shape of the earth is spheroidal, the line connecting any two points on the earth surface is not a straight line, but a curve.

When the surveys extend over a large areas or when the accuracy required is great, the curvature of earth has also to be taken into account.

For small distances the difference and the subtended chord

Plane Surveying:

The surveying where the effect of curvature of earth is neglected and earth's surface is treated as plane, is called surveying.

The degree of accuracy in this type of surveying is comparatively low.

Generally when the surveying is conducted over the area less than 260 Sq.Km., they are treated as plane surveying.

Plane surveying is conducted for the purpose of engineering projects.

Surveying:

The effect of curvature is taken into account.
It is also known as "Trigonometrical Surveying".
It is a special branch of surveying in which measurements are taken with high precision instruments.
Calculations are also made with help of spherical trigonometry.
It is generally adopted by the Great Trigonometrical Survey Department of India". (GTS).

Classification of surveying:

Land Surveying
Marine or Navigation or Hydrographic Surveying
Astronomical Survey.

Land Surveying: Land survey is a one, in which the relative points or objects on the earth's surface is determined.

Marine or Navigational or Hydrographic Survey:

Marine surveying is one in which in which the relative position of objects under water is determined.

Astronomical Surveying: It is one in which observations are made to locate the heavenly bodies such as sun, moon and stars.

Classification of Land surveying:

Topographical Survey:

It is used for determining the natural and artificial features of the country such as rivers, lakes, hills and canals.

Cadastral Survey:

It is used to locate additional details such as boundaries of fields of fields, houses and other properties.

City Survey:

It is used for town planning schemes such as laying out plots, constructing streets, laying water supply and sewer lines.

Engineering Survey : It is used to collect data for design and construction of Engineering works such as roads, railways, bridges dams etc.,

Principles of Surveying:

Principle 1:

A number of control points are fixed in the area concerned by adopting very accurate and precise methods.
The lines joining these control points will be control lines.
Other measurements are made to locate points inside these control lines.
Thus, main triangles and traverses are formed first.

The main triangles and traverses are divided into smaller ones by using less rigorous methods.

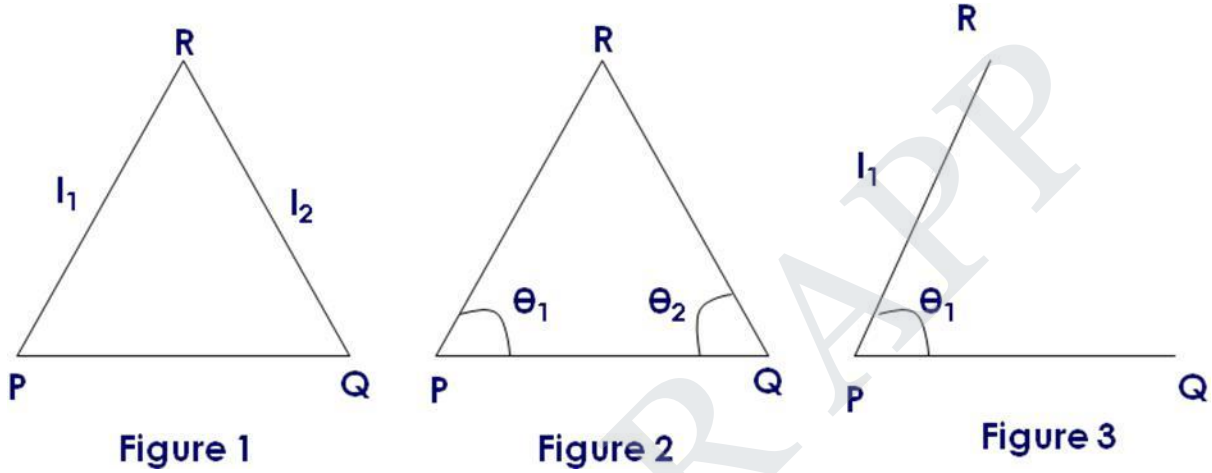
By doing so, accumulation of errors is avoided and any local error can be easily identified.

If survey work is started from a part (smaller triangle or traverse) and proceeded to whole there are chances of errors getting multiplied at every stage.

Hence any survey work should be from whole to part and not from part to whole.

Principle 2:

New points should be fixed by atleast two independent measurements.



Principle 2:

As per the Principle 2, the location of a new point involves one of the following.

(a) **Measurement of two distances.**
(b) **Measurement of two angles**
(c) **Measurement one angle and one distance**

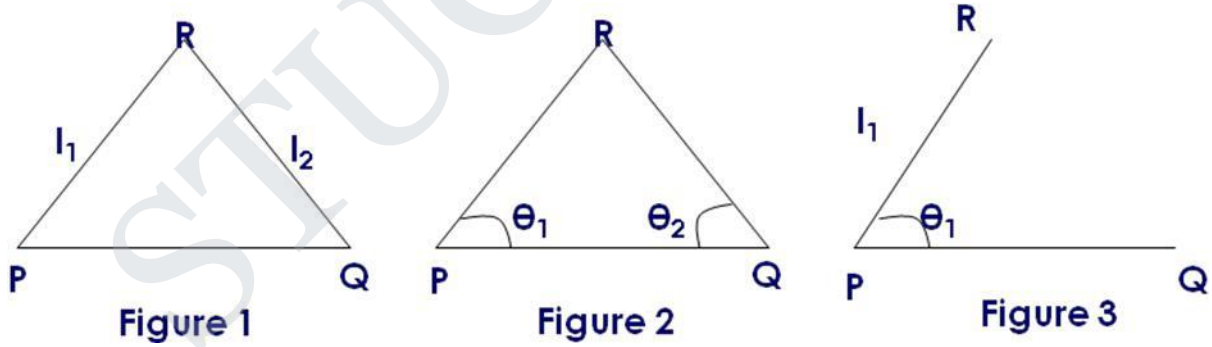


Fig 1: It shows the method of locating R with reference to known length PQ by using the known distances of PR (l_1) and QR (l_2)
Fig 2: It shows the method of locating R with reference to the length PQ by using the known angles QPR (θ_1) and PQR (θ_2)
Fig 3: It shows the method of locating R with reference to known length PQ by using the known distance of PR (l_1) and known angle QPR (θ_1)

Chain Surveying – Principle:

In chain surveying only linear distances on the field are measured.
These distances are used to define the boundary of field and mark simple details.

Principle :

It is to form a network of triangles by using the distances measured.
Better accuracy will be obtained if the triangles thus formed are nearly equilateral in shape.

Classification of surveying:

Chain Surveying
Compass Surveying
Theodolite surveying
Plane Surveying
Techeometric Surveying

Accessories used in Chain Surveying:

The different accessories used in chain surveying are
Metre Chain
Chain Pins (arrows)
Measuring Tape
Ranging rod/Offset rod.

Metric surveying chain:

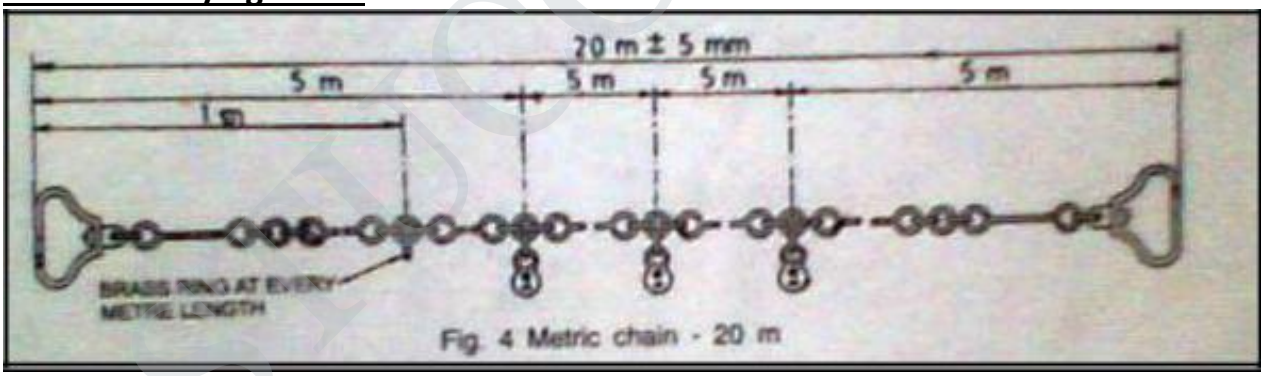


Fig. 4 Metric chain - 20 m

A surveying chain is a device used to measure distance between two points on the ground.
Metric chains are available in lengths of 5 m, 10m, 20m and 30 m.
20m – 30 m chain is normally used for the field of surveying.
A surveying chain contains brass handles with brass eyebolt and collar, galvanized mild steel links and wire rings.
In the case of 20 m and 30 m chains, brass tallies are provided at every 5 m length and indicating brass wire rings are attached at every metre length except where tallies are provided.

The distance between the outside faces of handles of a fully stretched out chain is the length of the chain.

The length of the chain, like 20m is engraved on the handles.

While measuring the long distance, the chain will have to be used a number of times.

Arrows are driven at the end of every chain length.

For holding the arrows in position, grooves are cut in the outside face of the handles.

The radius of the groove is the same as that the arrows.

For convenient handling of the chain, the handle joint is made flexible so that it is possible to swivel to handle round the eye bolt.

Chain Pins:

Chain pins or arrows are used with the chain for marking each chain length on the ground.

The arrow is driven into the ground at the end of each chain length is measured.

Chain pins the arrow should be made of good quality hardened and tempered steel wire of minimum tensile strength of 70 kg/mm^2.

The overall length is 400 mm and thickness is 4mm.

The wire should be black enamelled.

The arrow has a circular eye at the one end is pointed at the other end .

Pegs:

Wooden pegs of 15cm length and 3 cm square in section are used to establish the station points or the end points of a line on the ground.

They are tapered one end and are driven into the ground by using a wooden hammer.

About 4 cm is left projecting above the ground.

Measuring Tape:

There are different types of tapes are used. They are

(a) Cloth or linen type
(b) Metallic Tape
(c) Steel Tape
(d) Invar Tube.

Metallic tape and steel tapes are most commonly used.

Metallic Tape is made of varnished waterproof linen.

It is reinforced with fine brass copper or bronze wires.

Tapes are available in lengths of 10, 15, 20, 30 or 50 metres.

In metallic tapes every metre is divided into 100 divisions (cms).

In steel tapes, the centimetre division are also subdivided.

Ranging Rod:

It is also known as ranging pole or picket.

Ranging rod is used for ranging or aligning long lines on the ground in field surveying.

Ranging is a straight line means fixing a series of pegs or other marks such that they all lie on a straight line.

Ranging rods are used marking points on the ground so that the positions of the points are distinctly visible from some distant way.

The length of ranging rod may be 2 m and 3 m and its diameter is 30 mm.

Ranging rod made of steel tube has an internal diameter of 32 mm.

The ranging rods are made of well seasoned, straight grained timber of circular cross section.

Ranging rods should be straight and free from warps.

The deviation in straightness should not exceed 5mm in a 2 m length.

The ranging rod is painted in **red** and **white in** alternate band lengths of 200 mm each.

The bottom end of the rod is fitted with a pointed, hollow, cast iron shoe or steel shoe of 15 cm length.

Offset Rod:

It is a ranging rod with two short, narrow, vertical sighting slots passing through the centre of the section.

A hook is fitted of a groove is cut at the top to enable pulling or pushing of the chain through obstruction like hedges.

Offset rods are meant for setting outlines approximately at right angles to the main line.

Cross Staff:

It is used to set out right angles in chain surveying

It consists of four metal arms vertical slits mounted on a pole.

Two opposite slits are positioned along the length of a line (Main Line)

A line perpendicular to the main line is formed or sighted through the other two slits

Plumb Bob:

It consists of a solid conical piece and a string attached to it at its centre.

When in use, the solid piece is at the bottom.

It is used to test the verticality of the ranging rods and to transfer the points to the ground.

Plumb bob is used while doing chain surveying on sloping ground.

Unfolding and folding of chain:

Both the handles of the chain are held in the left hand and the other portions in the right hand.

The portion held in the right hand is thrown forward;

The person throwing moving backward himself.

The leader takes one handle of the chain and moves forward himself.

The leader takes one handle of the chain and moves forward till the chain is stretched to its full length.

The chain should be free from any kinks or bends.

After the completion of the work, the two handles are brought together and the chain is folded started with the middle pair.

The links are placed obliquely across each pair.

The folded chain is securely tied with a rope

Ranging a line:

It means fixing a series of pegs or other marks such that they all lie on a straight line.

Suppose P and Q are the two ends of a survey line.

- One ranging rod is driven Q.

The surveyor holds another ranging rod at P and stands at about 30 cm behind ranging rod.

The assistant goes with another ranging rod along the survey line and positions himself approximately in line with PQ at a distance less than a chain length from P.

The surveyor at P keeps his eye in line with PQ and signals to the assistant by way of adjusting the position of the ranging rod held by the assistant traversely.

This adjustment is continued till the intermediate ranging rod is truly in line with P and Q.

Outline of Chain surveying:

A base line which is a chain line is fixed.

The base line is aligned by ranging.

The length of the line is measured by chaining.

For this follower holds the zero end of the chain and the leader drags the chain to an intermediate point on the line

The leader straightens the chain by jerking till the chain lies exactly over the line.

The leader marks the end of the chain by driving the chain pin (arrow)

The follower holds the zero end of the chain at the chain pin point again

Thus the chaining is continued till the entire length is covered.

For locating the details, lateral measurements are taken to the objects.

These lateral measurements are called offsets.

If the offset is at right angles to the base line, it is called perpendicular offset.

If it is inclined to the base line, it is called oblique offset.

Depending upon the situation, perpendicular or oblique offsets are taken

The length are measured are entered.

Advantages and disadvantages of chain surveying:

Advantages:

It is simple

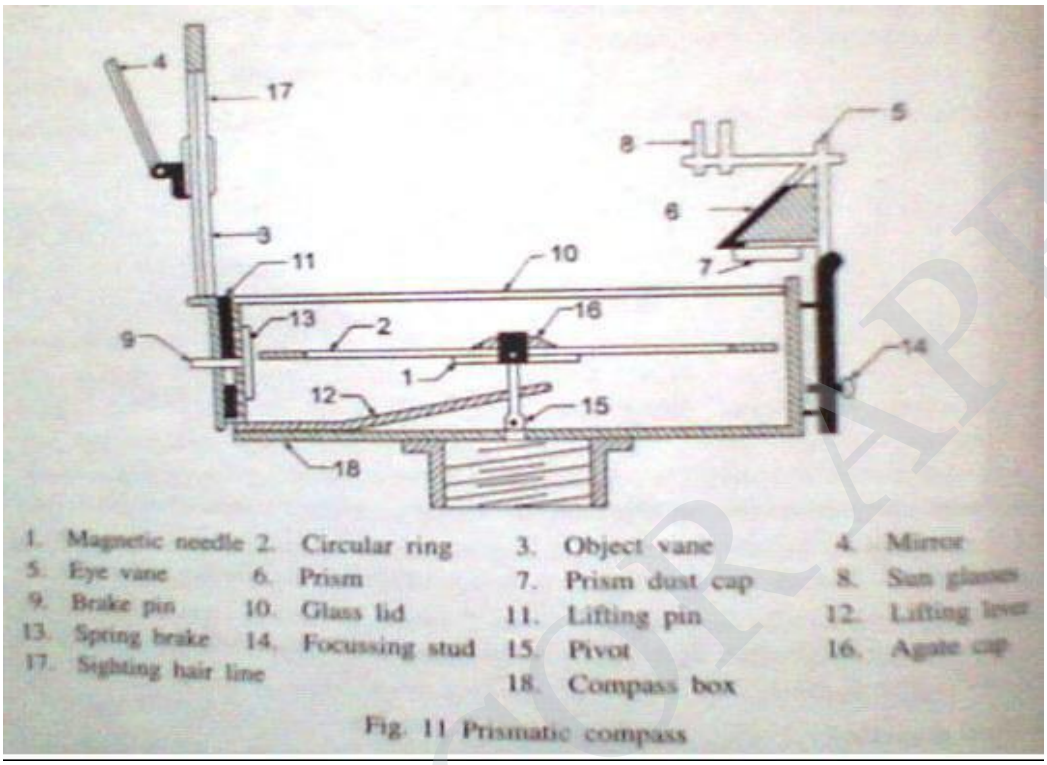
It does not require any costly equipment

It is adopted for preparing plans for small area

Disadvantages:

It cannot be used for large areas
It cannot be used in thick bushy areas with ups and downs.
Chain surveying is not always accurate.

Compass Surveying – Prismatic Compass:



1. Magnetic needle 2. Circular ring 3. Object vane 4. Mirror
5. Eye vane 6. Prism 7. Prism dust cap 8. Sun glasses
9. Brake pin 10. Glass lid 11. Lifting pin 12. Lifting lever
13. Spring brake 14. Focussing stud 15. Pivot 16. Agate cap
17. Sighting hair line 18. Compass box

Fig. 11 Prismatic compass

Whenever a number of base lines are to be run for obtaining the details as in traversing, just linear measurements made by chain surveying will not be sufficient.
The angles included between the adjacent lines should also be measured
Compass is one of the instruments used to measure the angles.

Prismatic Compass:

Description:

A magnetic needle is balanced over a pivot in a circular box of 85 mm to 110 mm in diameter.
A graduated aluminium ring is attached to the magnetic needle.
An agate cap keeps the aluminium ring stable.
The box is covered by a glass lid.
Object vane and eye vane are provided at diametrically opposite ends.
Eye vane caries a reflecting prism which can be raised or lowered as desired.
A vertical horse hair or fine wire is provided at the middle of the object vane.

The graduations in the aluminium ring are made in the clockwise direction starting with 0^o at South and 180^o at North with inverted markings.

A triangular prism fitted below the eye slit enables magnification of readings to suit observer's eye.

Based on this prism arrangement, the compass is named prismatic compass.

Compass is fixed over a tripod with ball and socket arrangement.

A braked pin is provided below the object vane to damp the oscillations of the magnetic needle while taking readings.

Working Principle:

The magnetic field aligns itself with the magnetic meridian (N-S direction)

The line of sight is actually the line joining the object vane and eye vane

The angle between the N-S direction and the line of sight is observed in the compass

This angle is actually the angle between N-S direction and the line on the ground

This angle made by the line with the N-S direction is called the **bearing** of the line.

Compass is used to measure the bearing of the different lines from which the angles included between the adjacent lines are computed.

How to take reading using compass:

The compass is centered over the station by dropping a small piece of stone from the centre of the bottom of the compass.

A plumb bob is used for centering.

The compass is levelled by adjusting the ball and socket till the top of the box is horizontal.

The graduated ring should move freely after having levelled the instrument.

Suppose the bearing of a line PQ is to be observed.

The compass is centered over P.

It is levelled.

The prism and the object vane are kept in vertical position.

The compass is turned slowly till the ranging rod already erected at Q is bisected.

In this position, the ranging rod, the object and the eye vane all lie in the same line.

The focusing prism is raised or lowered till the readings were clear and sharp.

The reading in the ring cut by the object hair line is taken after damping the oscillations of the ring by pressing the brake pin.

Definitions:

Magnetic Bearing:

- It is the angle between the magnetic meridian and the line.
- The angle is always measured in the clockwise direction
- It is the direction shown by a freely suspended magnetic needle

The magnetic meridian is also called bearing.

True Bearing:

- True bearing of a line is the angle between the true meridian and the line.

The angle is always measured in the anticlockwise direction.

The true meridian is the line joining the geographical north and south bearings.

Whole Circle Bearing:

The bearing of lines measured from the **North** is called **Whole Circle Bearing.**

The angle is reckoned in the **clockwise direction from 0^o** coinciding with the north.

Quadrant Bearing:

The whole circle is divided into four quadrants.

The bearing is expressed with N or S as prefix and E or W as suffix.

Quadrant Bearing is also known as **Reduced Bearing.**

Fore Bearing and Back bearing:

Every line has two bearing namely fore bearing and back back bearing

Fore bearing is the bearing taken in the direction of surveying and Back bearing is the bearing taken in the reverse direction.

The difference between the fore bearing and the back bearing should be 180^o.

It means that one or both stations of the line are subjected to **local attraction**.

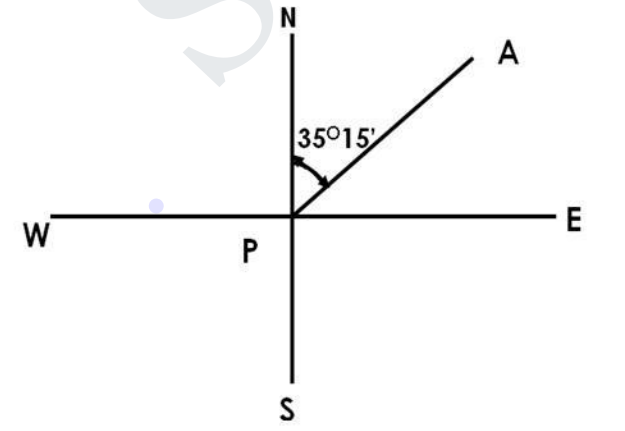
Thus, local attraction is the influence caused on the measured bearings of lines due to the presence of materials like railway track, current carrying wires or cables, etc.,

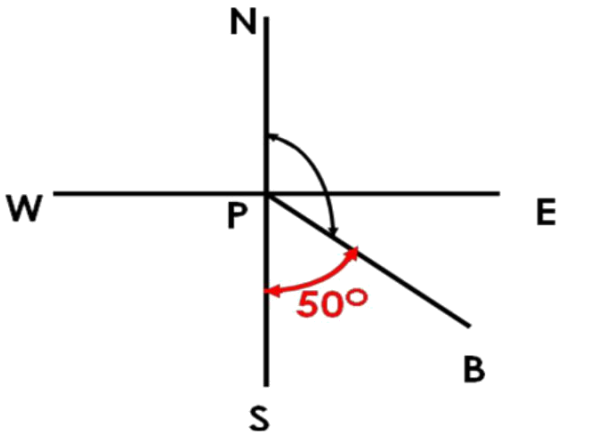
To find QB from WCB:

Solution :

Line PA lies in 1^{st} quadrant.

Quadrant Bearing bearing of PA = N 35^o 15' E

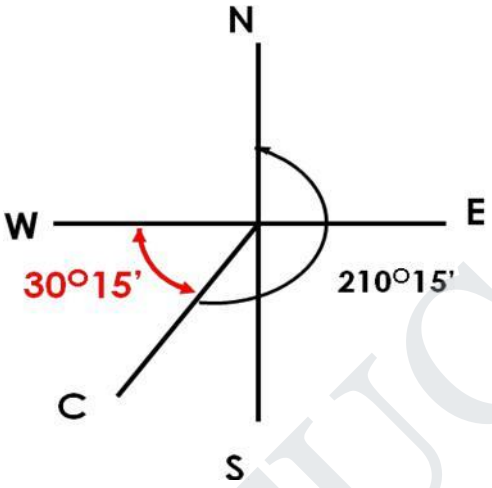




Solution :

Line PB lies in 2nd quadrant.

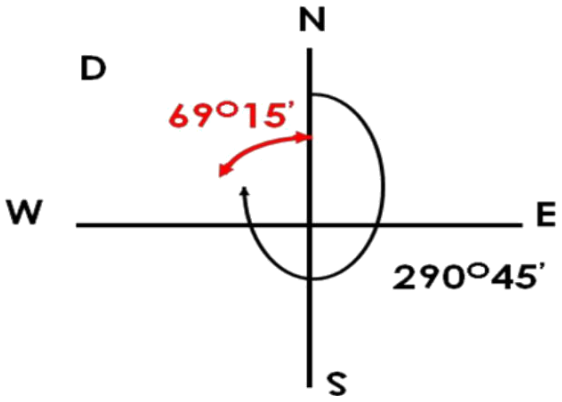
Quadrant Bearing bearing of PB = S 50^{O} 00’ E



Solution :

Line PC lies in 3rd quadrant.

Quadrant Bearing bearing of PC = S 30^{O} 15’ W



Solution : **Line PD lies in 4th quadrant.Quadrant Bearing bearing of PD = N 69^{o} 15' W**

To find Whole Circle Bearing from QB:

WCB = PA –N 15^{o} E

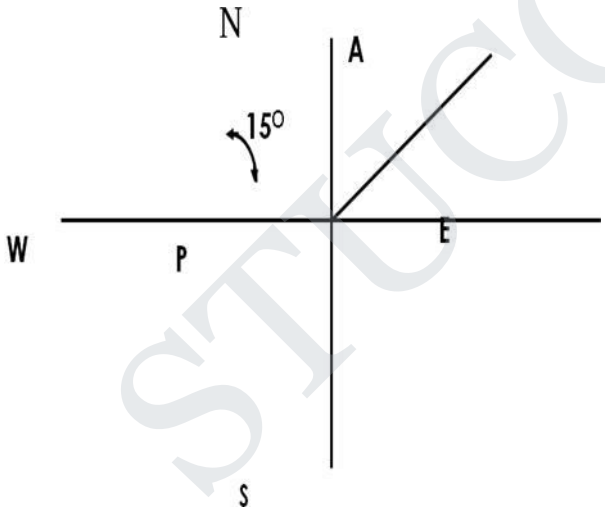
(ii) WCB = PB – S 25^{o} 45' E

WCB = PC – S 45^{o} 30' W

WCB = PD – N 10^{o} W

Qn: PA – N 15^{o} E

Ans: Line PA is in the first quadrant. Its WCB is 15^{o}



Levelling:

It is a surveying method used to determine the level of points/objects with reference to the selected datum.

It is also used to set out engineering works.

Uses of Levelling:

To determine the difference in levels of points/Objects

To obtain contour map of an area

To obtain cross section of roads, canals etc.,

To determine the depth cutting and filling in engineering works.

To establish points or erect machinery or construct a building component at a predetermined level.

Important Terms:

Bench Mark: It is surveyor's mark cut on a stone/ rock or any reference point used to indicate a level in a levelling survey.

Reduced Level:

Reduced level of a point is the level of the point with respect to the level of permanent feature or bench mark.

It indicates whether the point is above or below the reference point (datum).

Instruments used in leveling:

Instruments used in levelling are,

Levelling instrument

Levelling staff

Levelling Instrument :

Simplest form of levelling instrument is dumpy level.

The different parts of levelling instrument are,

Telescope (b) Eye-piece (c) focussing knob (d) level tube (e) cross bubble (f) foot screws levelling head (h) diaphragm (i) ray shade

Dumpy Level:

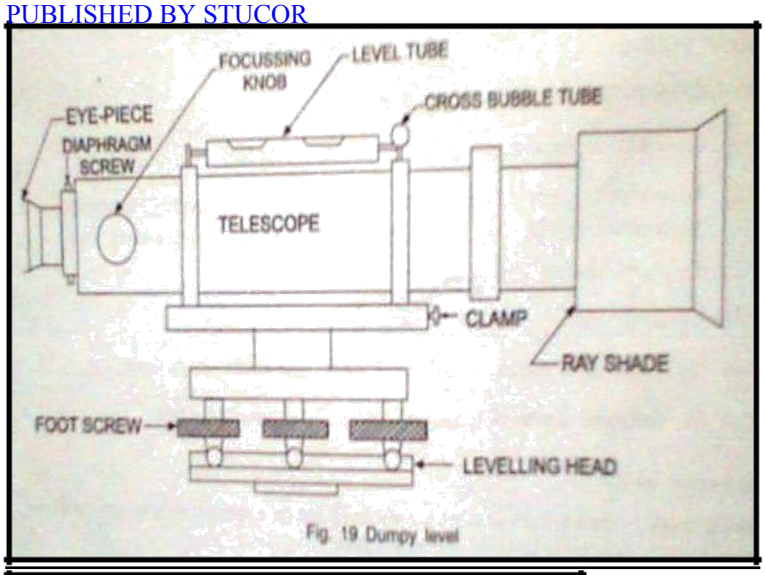
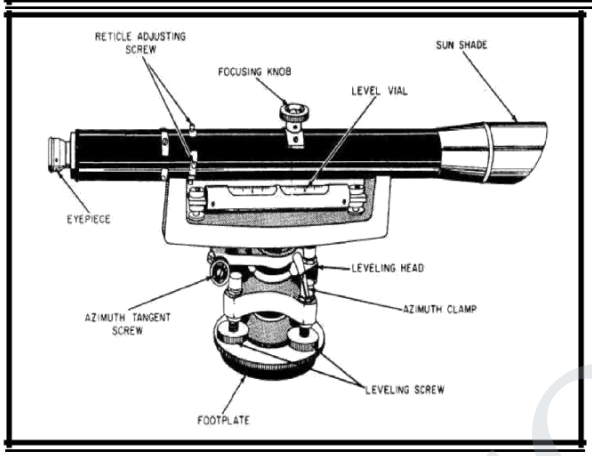


Fig. 19 Dumpy level



Levelling Staff:

It is an important accessory used with levelling instrument at the time of conducting levelling survey.

Reading is taken on the levelling staff held properly at the point concerned by viewing through the telescope of the levelling instrument.

Usually 4 m levelling staff may be used of folding type or telescopic type

Aluminium levelling staff foldable at every metre length has also came to the market.

The levelling staff consists of three pieces.

The topmost one slides into the middle one and the middle portion slides into the bottom one.

When the staff is fully pulled, it will read exactly 40 decimeters (4m) from the bottom shoe.

Graduation in levelling staff:

Every metre length is divided into 200 divisions.

The divisions are painted in black and white alternately of thickness 5 mm each.

The graduation figures are marked at every decimeter length.

The number indicating metre is in red and the decimeter number is in black.

Thus, a graduation figure of 24 indicates 2 metres and 4 decimeters.

The graduation are made continuously one above the other in the same line.

The division lines should be parallel to the base of the bottom shoe and perpendicular to the length of the staff.

The edges of the division lines should be straight sharply defined.

They should be clear and made distinctly visible by properly contrasting.

The graduation colour paints used should not crack or blister when exposed to adverse or atmospheric conditions.

Important Terms in leveling:

Station : In Levelling, the term station always refers to the point where the levelling staff is held and not the instrument station.

Height of Instrument : It is the elevation of the line of sight with reference to the assumed datum.

Back Sight (B.S) : It is the reading taken on the staff held at a point, the elevation of which is known already. It is useful to know the new height of the instrument.

Foresight (F.S): It is the reading taken on the staff held at a point of unknown elevation. From, F.S., the height of the line of instrument above the point can be obtained. It is useful to find the elevation of the point.

Change Point : It is the point at which the fore sight is taken from one instrument station and back sight is taken from the next instrument station.

Intermediate station : A point between two change points is known as intermediate station. Only one reading is taken on the intermediate station.

Methods of Levelling:

Method 1 : It is done with only one setting of the instrument.

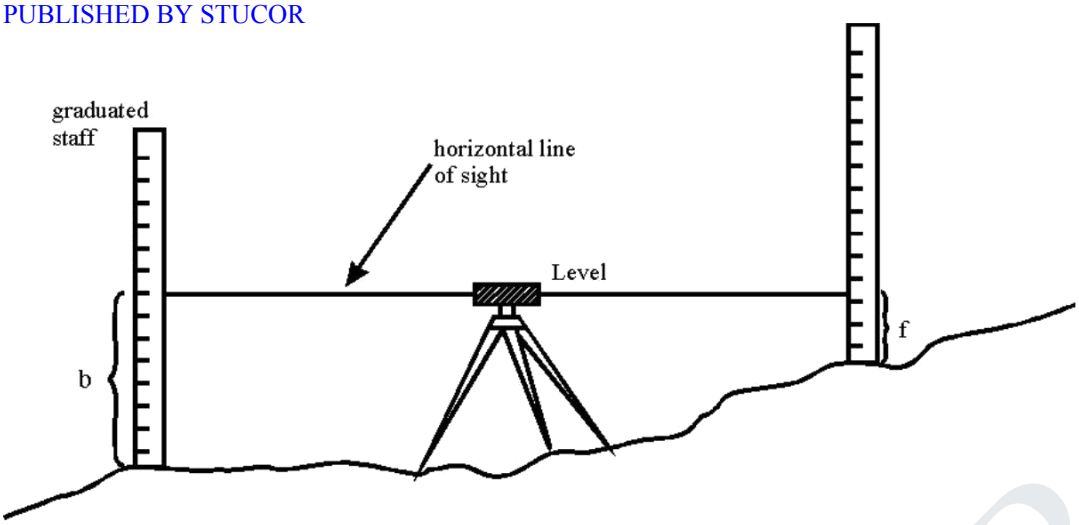
Method 2: When the two station points are wide apart and the instrument is set up at more than one point and the levelling is carried out.

Method 1
With only one setting of the instrument:

The instrument is set up at a point between P and Q and the temporary adjustments carried out.

The levelling staff is held at P, the elevation of which is known already.

A back sight is taken on the staff held at P. The staff is then held at Q and the foresight is taken.



δh = backsight - foresight
= b - f

Direction of travel

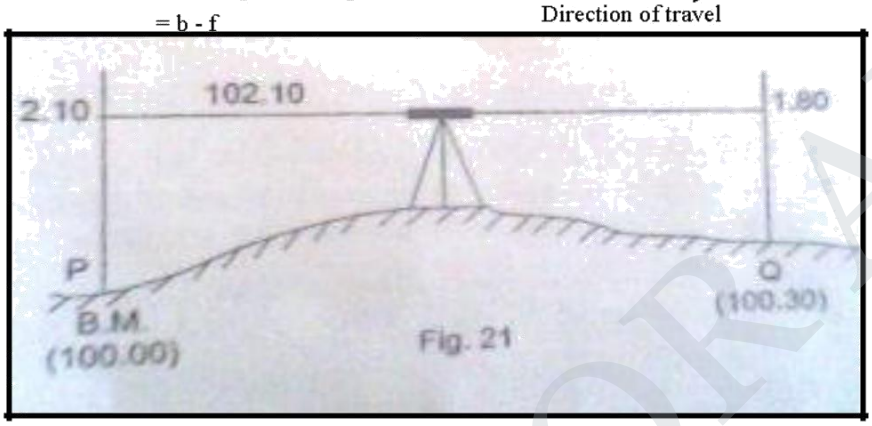


Fig. 21

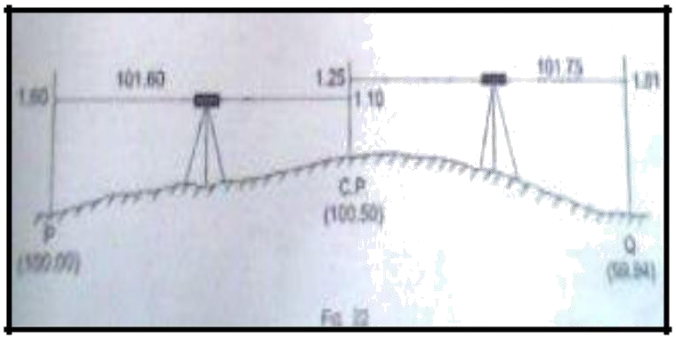
Height of the instrument = **Known elevation of P + the staff reading at P**
= 100.00+ 2.10 = **102.10 m**

Elevation of Q = **Height of the instrument – the staff reading at Q**
= 102.10 – 1.80 = **100.30 m**

Method II

When the station points are wide apart, the instrument is setup for at more than one point and levelling is done
(Height of Collimation Method)

A change point (C.P) is established in between P and Q.
A back sight is taken at P and a fore sight is taken at the change point.
The instrument is shifted to another point between the change point and Q.
A back sight is taken at the change point and a fore sight is taken at Q.
Any number of change points are established as required.
This method is known as Height of Collimation method.



The elevation of change point = **Elevation of P + Back sight at P –**
Fore sight at change point (C.P)
= 100.00+1.60-1.10 = **100.50 m**

The second height of the instrument = The elevation of change point+
Back Sight at change point
= 100.50+1.25 = **101.75 m**

The elevation of Q **= The second height of instrument –**
foresight at Q
101.75 – 1.81 = **99.94 m**

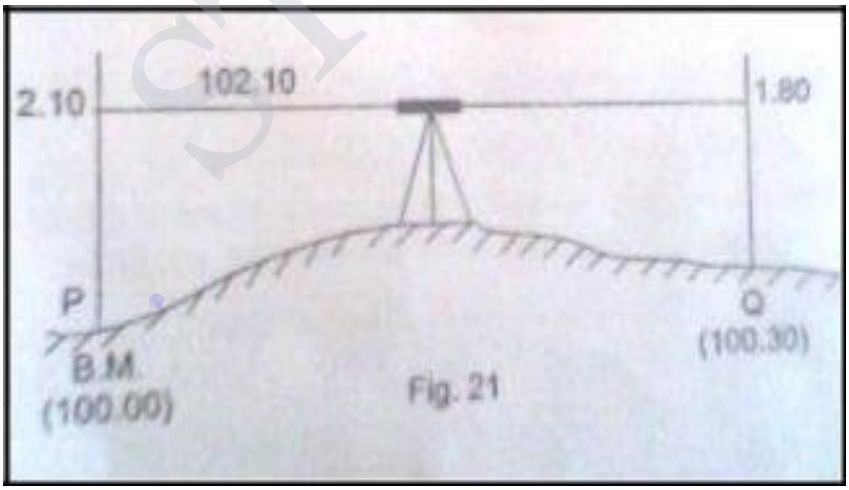
Rise and Fall Method of calculating the level:

The staff readings of the points observed from the same setting of the instrument are compared.

It is found whether a point is above or below the preceding point.

If the point is above, the staff reading will be less than the preceding point. The difference between the staff readings is called **rise.**

If the point is below the preceding point, the staff reading will be greater than that at the preceding point. The difference between the staff readings is termed **fall.**



The difference between the staff readings

at P and Q = 2.10 – 1.80 = 0.30 (rise)

Hence, level of Q = Elevation of P + Rise

= 100.00+0.30 = 100.30 m

Arithmetical Check of Rise and Fall method:

$$\sum B.S - \sum F.S = \sum Rise - \sum Fall = Last\ R.L - First\ R.L.$$

3.670 – 1.290 = 3.235 – 0.855 = 102.380 – 100.00

2.380 = 2.380 = 2.380

Fly Levelling:

Any number of change points are established as required during levelling. This method is known as fly levelling.

It is adopted to find the difference in level between two points, when

The two points are too far away

the difference in level between two points is large

there are no obstructions in between the two points concerned.

Calculation of Areas:

One of the purposes of surveying is to determine the area to be surveyed.

The area of the land obtained by surveying actually refers to the area as projected on a horizontal plane.

There are different methods of computing the area of land using the data obtained by surveying.

Calculation of area by Trapezoidal Rule :

In trapezoidal, a convenient base line is established.

Perpendicular distances from the base line to the boundary of the land concerned are measured at regular (equal) intervals along the base line.

These perpendicular distances are called ordinates.

Trapezoidal rule:

Total Area, $A = d/2 (h_1+h_n+2(h_2+h_3+\ldots\ldots+h_{n-1}))$

Simpsons Rule:

This rule is applicable only if the number of ordinates is odd.

•

$A = d/3$ **(First Ordinate+ Last Ordinate + 2 (sum of odd ordinates)+ 4(sum of even ordinates)**

i. e. $A = d/3 \quad (h_1+h_n+ 2(h_3+h_5+h_7+\ldots..+h_{n-2})+ 4(h_2+h_4+\ldots.+h_{n-1})$

If the number of ordinates is even, the area of the last trapezoid is calculated separately and added to the result.

Problems on Simpsnon's Rule and Trapezoidal Rule:

The following perpendicular offsets were taken at 10 m intervals from a survey line to an irregular boundary line:
3.60, 2.80, 4.50, 8.25, 7.85, 6.45, 5.35.
Calculate the area enclosed between the survey line and boundary line by trapezoidal rule and Simpson's rule.

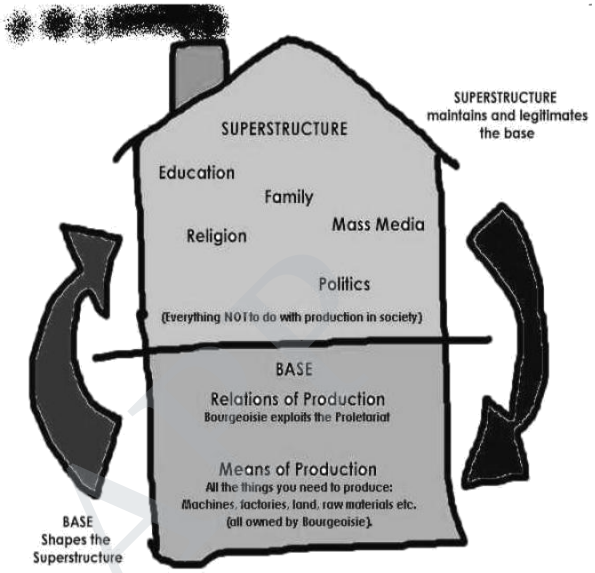
A series of offsets were taken at 5 m intervals from a chain line to a curved edge.
1.50, 1.66, 2.25, 2.80, 1.75, 1.95, 0.
Calculate the area between the chain line and the irregular boundary to the curved edge by the Simpson's rule and Trapezoidal Rule

UNIT 3

BY STUCOR

UNIT III

Foundation, Superstructure, Simple Stresses and Strains, Dams, Bridges and Interior Design



Super structure and Substructure

A structure consists of two parts. Namely,

Superstructure – Above the plinth level
Sub Structure - Below the plinth level.

It is also known as foundation.
The soil on which the foundation rests is called **foundation soil.**

Foundation:

Objectives of foundation:

To distribute the total load coming on the structure on a larger area
To support the structures
To give enough stability to the structure against various disturbing forces, such as wind and rain.

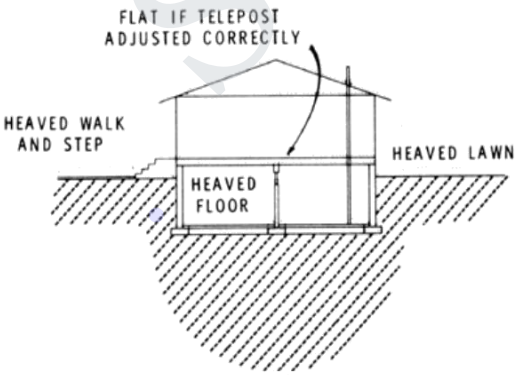
Types of foundation

Foundation may be broadly classified,

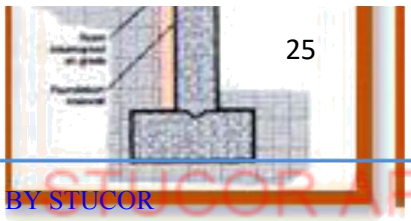
Shallow Foundation
Deep Foundation

Shallow Foundation:

When the depth of the foundation is less than or equal to its width, it is defined as ***shallow foundation***.



Isolated Column footing



Deep foundation :

Deep foundation consists of pile and pier foundation.Pier foundations are rarely used for buildings.This consists in carrying down through the soil a huge masonry cylinder which may be supported on solid rock.

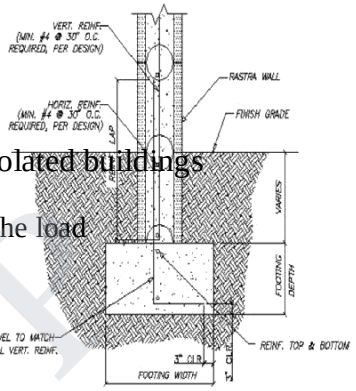
~~***Types of shallow foundation:***~~

Types of shallow foundation:

~~***Isolated column footing:***~~

It is used in framed structures where several columns are to be constructed, isolated buildings can be adopted.

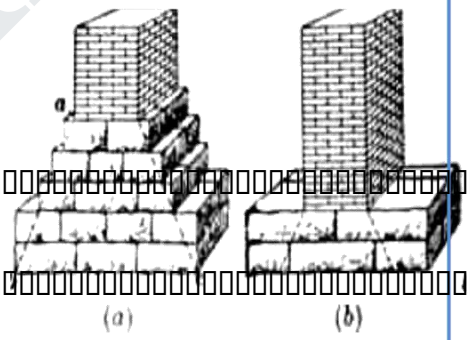
Wall footing: It is the footing provided throughout the length of the wall in the load bearing walls, then it is called wall footing.



TYPICAL WALL FOOTING

Stepped Footing:

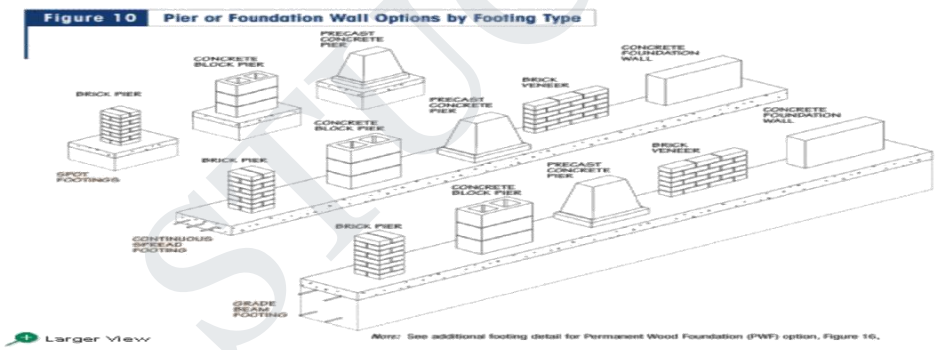
- When the ground is sloping, stepped footings are provided.
- It consists of two or more footings of brick or stone masonry and a concrete bed below the ground level.
- The overlap between two layers of foundation concrete slab is equal to the depth of concrete slab or two times the height of the step, whichever is more.



Continuous footing:

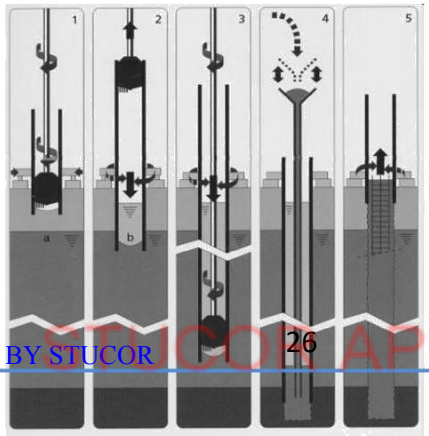
n this type of footing, a single continuous RC slab is provided as foundation for three or more columns in a row.

his type of footing is more suitable to prevent the differential settlement in the structure and for the safety against the earthquake**Steppedfooting.**



Continuous footing

Types of deep foundation



Pile foundation:

Pile is an element of construction used as foundation.

It may be driven in the ground vertically or with some inclination to transfer the load safely.

Loads are supported in two ways. i.e., either by the effect of friction between the soil and the pile skin or by resting the pile on a very hard stratum.

The former is called ***friction pile*** and later one is the ***load bearing pile.***

2.Under reamed pile:

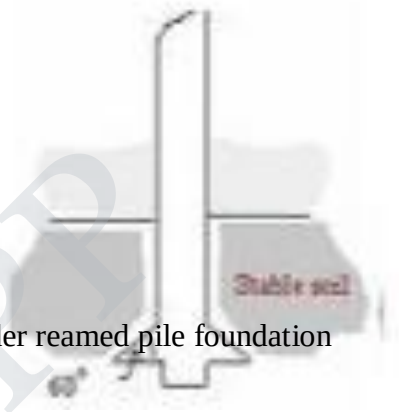
Structures build on **expansive soils** often crack due to the differential movement caused by the alternative swelling and shrinking of the soil.

Under reamed piles provide a satisfactory solution to the above problem.

The principle of this type of foundation is to transfer the load to the hard strata which has sufficient bearing capacity to take the load.

Single and double under reamed piles may also be provided for foundation of structures in poor soils overlying firm soil strata.

Pile Foundation



Under reamed pile foundation

Failures of foundation:

Unequal settlement of soil
Unequal settlement of masonry
Withdrawal of moisture from sub soil.

Unequal settlement of soil:

Reasons

Due to unequal distribution of load
Varying bearing capacity of soil
Eccentricity of load.

Prevention

The foundation should rest on rock or hard moorum.
Check the allowable bearing pressure not exceeded
Care should be taken on the eccentricity of the load.

Unequal settlement of masonry:

Reasons

1. Mortar joints may shrink and compress, leading to unequal settlement of masonry.

Prevention

The mortar to be used in the masonry, should be stiff.

The masonry should be raised evenly and should be watered properly.

Withdrawal of moisture from the sub soil:

This occurs where there is considerable variation in the height of the water table.

The precaution needed to avoid this type of failure is to drive piles up to the hard rock level.

Superstructure:

Superstructure mainly consists of walls, doors windows and lintels.

The purpose of superstructure is to provide the necessary utility of the building, structural safety, fire safety, sanitation and ventilation.

MASONRY

Types of masonries:

Brick Masonry
Stone Masonry

Brick Masonry (Bonds in Brick work):

Stretcher Bond:

All the bricks are arranged in stretcher courses.

The stretcher bond is useful for one brick partition as there are no headers.

As the internal bond is not proper this is not used for walls of thickness greater than one brick.


Stretcher bond

Header Bond

All bricks are arranged in header courses. It is used for curved surfaces since the length

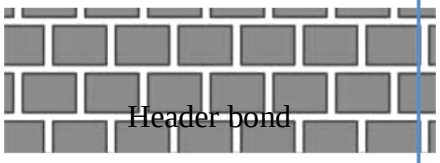
Will be less

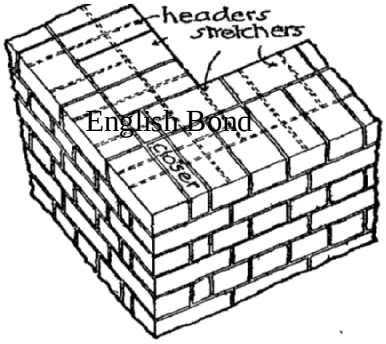
English Bond:

It is most commonly used type of bond.
It is the strongest type of bond.
It is used for all wall thicknesses.

English bond consists of headers andStretchers in alternative courses of elevation.

A queen closer is placed next to the quoin header in each header course to the full thickness of wall. Each alternative header lies centrally over a stretcher of the stretcher course.


Header bond



English Bond

Flemish Bond:

Headers are distributed evenly as shown.

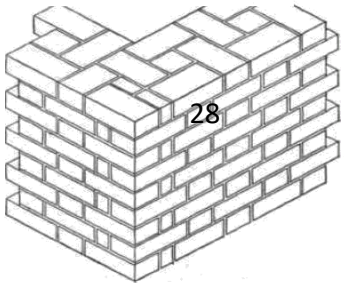
The peculiarities of a Flemish bond are as follows.

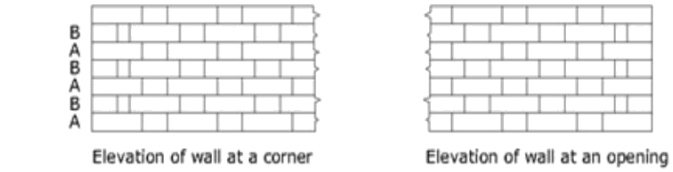
In every course headers and stretchers areplaced alternatively.

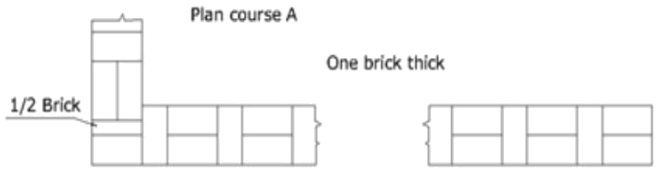
The queen closer is put next to the queen header in alternate course to develop the lap

Every header is centrally supported over a stretcher below it.

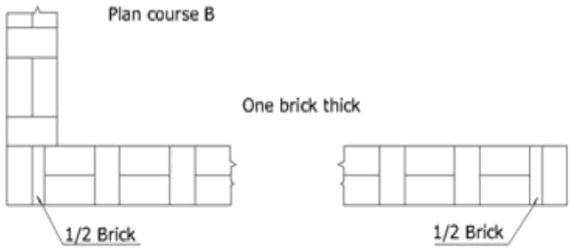
The Flemish bond may be either a double Flemish or Single Flemish bond.







Flemish Bond



Racking Bond: It is used for thick walls.

It is subdivided into
Diagonal bond
Herringbone bond.

***Diagonal bond*:** Bricks are laid diagonally. Internal placing of bricks is made in one Direction only at certain angle of inclination.

Herringbone **:** The bricks are laid at an angle of 450 from the centre in both directions.

Stone Masonry

It is a natural choice for masonry.
Its durability has been demonstrated and massive structures.
Coal tar, paraffin, linseed oil or solution of alum and soap are the preservatives used to prevent the stone from the effects of rain water, wind etc.,
Stone masonry is the construction carried out using stones with mortar.
Because of high cost of transportation, painful and costly work of dressing and need for experienced labour, stone masonry is presently not popular.
Further stone masonry walls occupy more space compared brick work.

Types and Uses of stones

Types of stone masonry :

Dense stones like granites and quartzite
Fire resistant stones and sand stones
Soft stones like lime stones, marble and slate used for carvings, arches etc.,

Uses of stone masonry:

Foundation, floor, walls, lintels, column, roofs, etc.,
Walls, roofs, lintels for temples, monuments etc.,
For facing works in brick masonry to give massive appearance.

Classification of stone masonry

Rubble Masonry

Random rubble masonry

Uncoursed and coursed

Squared rubble masonry

Uncoursed and coursed

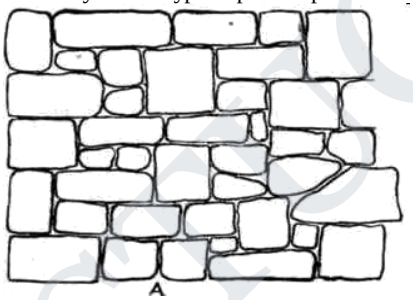
Polygonal rubble masonry

Ashlar Masonry

Ashlar fine masonry
Ashlar rough tooled masonry
Ashlar rock or quarry faced masonry
Ashlar chamfered masonry
Ashlar facing masonry

Random Rubble masonry:

Random rubble masonry, uses stones of Irregular shapes.
The stones are arranged in a random fashion
The joints are points to achieve a good appearance
The efficiency of this type depends upon the workmanship.



Square rubble masonry

In square rubble masonry, the stones are roughly squared with straight edges and sides with hammer blows.

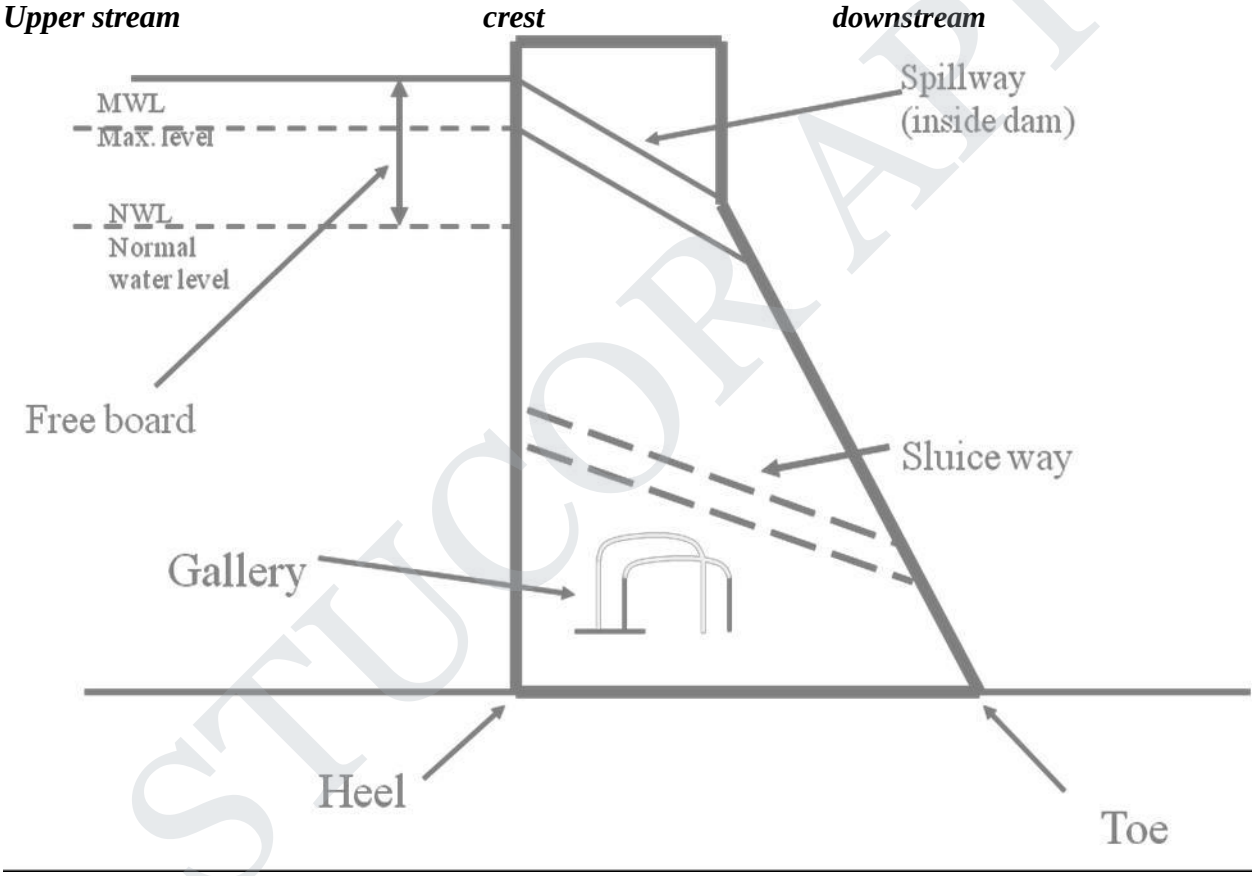
Ashlar Masonry:

In Ashlar masonry, no irregular stones are used.
The entire construction is done using square or rectangular dressed stones.
The sides and faces of the stones are dressed finely with chisel.

Dams

A dam is a impervious barrier or an obstruction constructed across a natural stream or a river to hold up water on one side of it upto a certain level.

Structure of Dam:



Purpose of dams:

The stored water in the dam can be continuously used for irrigation.
The reservoir forms a very good source for water supply for areas where ground water is inadequate
If sufficient head of water is stored, then that can be used for power generation.
The reservoir forms a good place for breeding of fish, which is a considerable wealth for a dam

Classification of dams:

Dams are broadly classified into,

Rigid Dams
Non rigid dams.

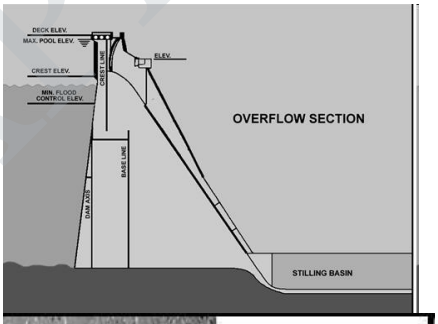
Rigid dams:

These dams are constructed using rigid construction materials.
The construction materials used are, stone or brick or reinforced cement concrete.

Rigid dams are further Classified into,

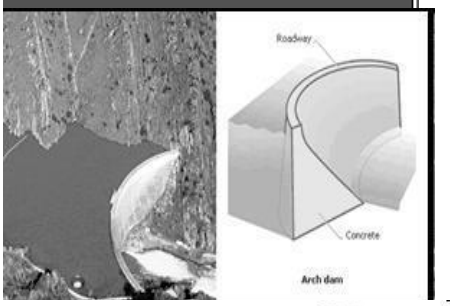
Solid gravity dam
Arch Dam
Buttress dam
Timber and steel dam

Solid Gravity Dam:



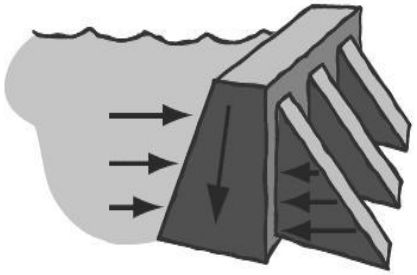
A gravity dam is defined as a structure which is designed in such a way that its own weight resists external forces.
It is more durable and has maximum rigidity.
It requires less maintenance compared to other types.
This type can be constructed of masonry or concrete.
Nowadays, concrete dams are prevalent.

Arch Dam:



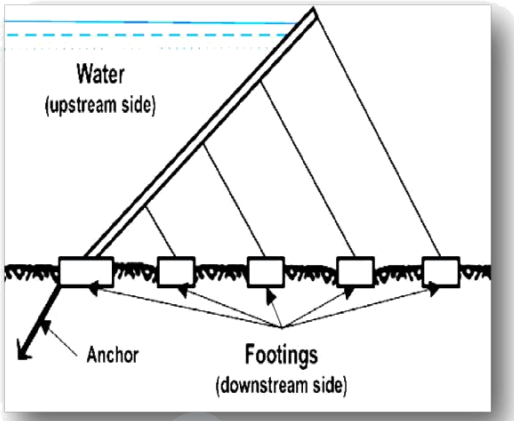
Arch dams are curved in plan.
This structure less Massive
when compared to gravity dam
The forced exerted by the stored water on upstream side will be transferred by
the abutments of the arch dam.
This dam is suitable for narrow valleys but major requirements is sound abutments.
An arch dam is economical only when the length of dam is less than its height.

Buttress dam:



A buttress dam has relatively thin sections when compared to a gravity dam.
It consists of a sloping section buttresses and a base slab. The sloping membrane (Face slab) first takes the water load and transfer to the buttresses which are specific intervals.
The buttresses in turn transfer the load to the base slab which forms the foundation part of the dam.

Timber and Steel Dam:



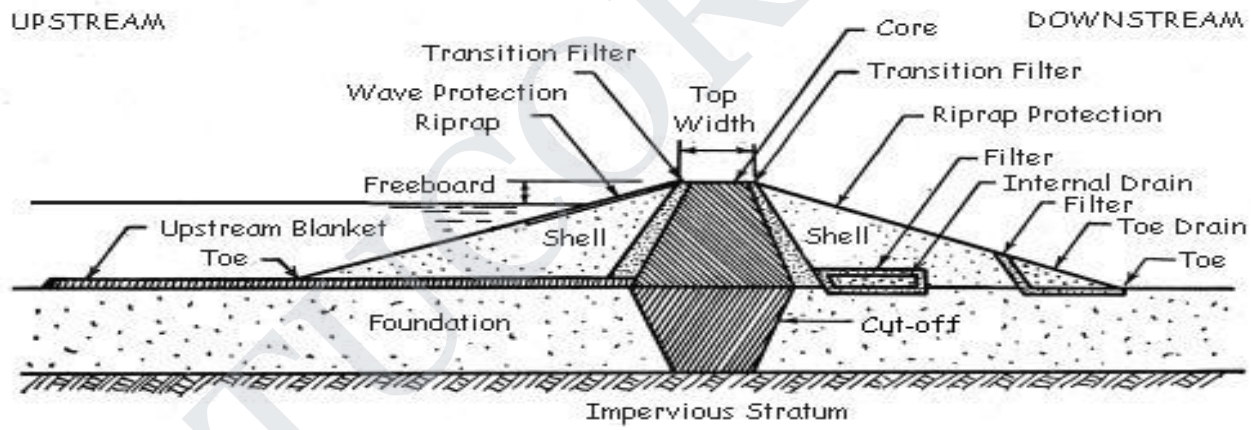
Timber and steel dams are not generally used for bigger dam sections.
A timber dam is generally adopted for temporary requirements to enclose certain work sites or to divert the flow.
After the main structure is built the timber dam will be dismantled.
Timber dams are generally made water tight.
Steel dams are not common in use. But it is possible to construct the dam with steel upto a height of 15-18 m

Non Rigid Dams:

Non rigid dams have a trapezoidal basic profile.

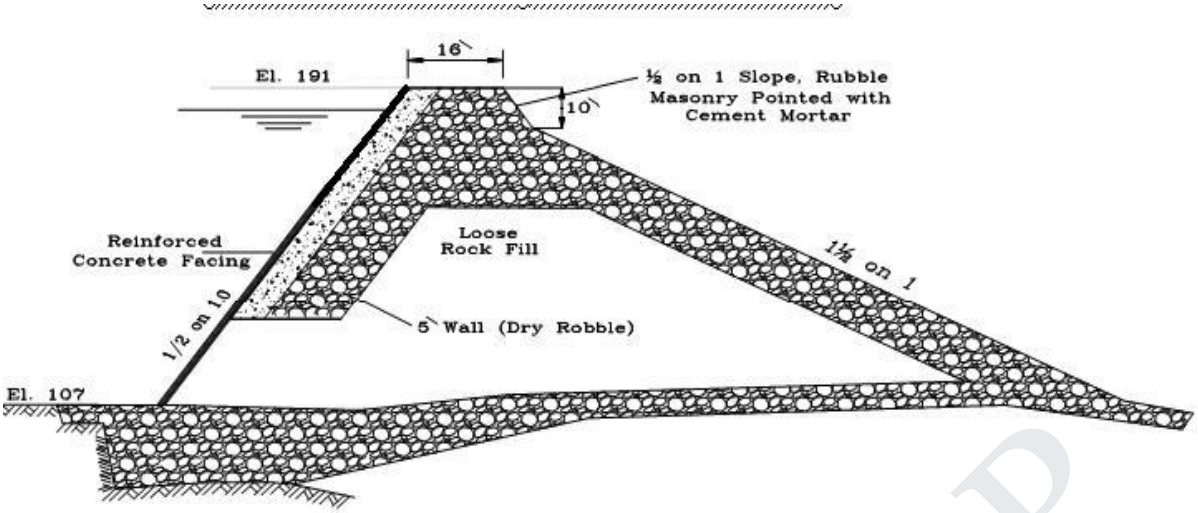
Types of Non Rigid dams
Earth Dams
Rock fill dams.

Earth Dam:
Earth dams are made of soil with minimum processing using primitive equipment
These are built in areas where the foundation is not strong enough to bear the weight of a gravity dam.
As the construction material of the dam is ordinary soil which is cheaply available the cost of construction of this dam is less than rigid dam.



Rock Fill Dam:
Rock fill dams are made of loose rocks and boulders piled in the river bed.
A slab of reinforced concrete is often laid on the upstream face to make it water tight.
There are more stable than earthen dams and les stable than gravity dams.
The dam section generally consists of dry ruble stone masonry on the upstream

side and loose rock fill on the downstream side.



Section through Beaver Park Dam, Colorado.
(Eng. News, 73,p.660)

Bridges

Definition: A bridge is a structure providing passage over an obstacle such as an vale, road, railway, canal, river without closing the way beneath.
The required passage may be road, railway, canal, pipeline, cycle track or pedestrians.

Components of a bridge:
Pier : These are provided between the two extreme supports of the bridge (abutments) and in the bed of the river to reduce the span and share the total load acting on the bridge.
Abutments: The end supports of a bridge superstructure are called abutments. It may be of brick masonry, stone masonry, or RCC. It serves both as a pier and as a retaining wall.

The purpose of abutments are,

To transmit the load from the bridge superstructure to foundation.
To give the final formation level to the bridge superstructure
To retain the earth work of embankment of the approaches.

Approaches: These are the length of communication route at both ends of the bridge.

***Hand rails*:** Hand rails are provided on both sides of a bridge to prevent any vehicle from falling into the stream.

Technical Terms:

Span : IT is the centre to centre distance between two approaches
Culvert: It is a small bridge having maximum span of 6 m
Vent way: It is the culvert having a length of less than 1m
High Flood Level (HFL): IT is the level of highest flood ever recorded.
***Ordinary flood level (OFL*):** It is the flood level which generally occurs every year.

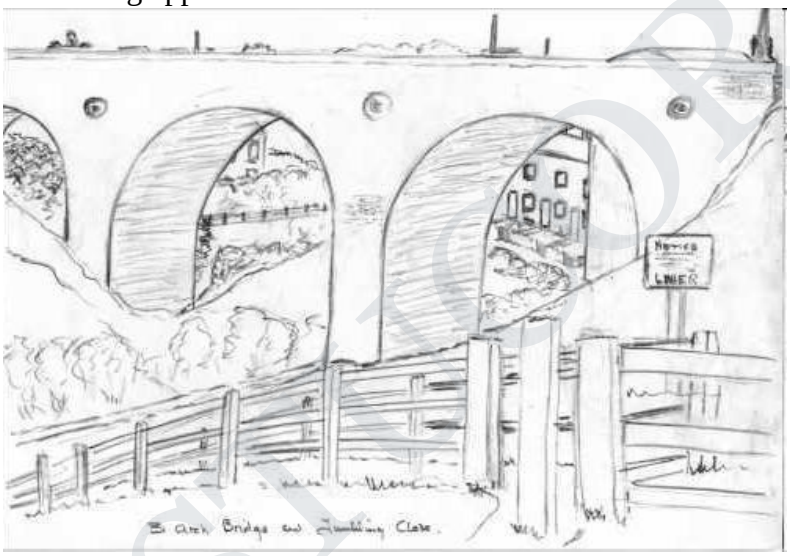
1.Permanent bridges
- Back bridges
- Through bridges
- Semi through bridges
- Straight bridges
- Skew bridge

According to type of superstructure:

1.Arch Bridge
- Slab Bridge
- T beam and slab bridge
- Bow string and girder bridge
- Steel Arch bridge

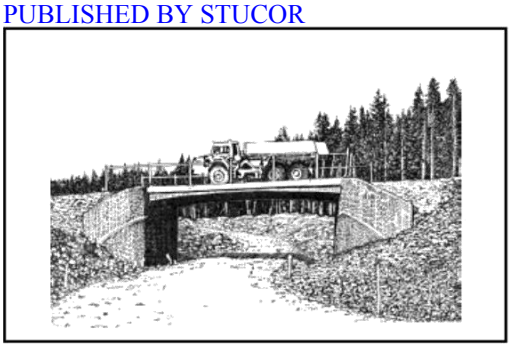
Arch Bridge : Arch bridges are often Used because of their pleasing Appearance. The advantages of Arch bridges are,

- There will not be bending any Where in the arch
- Vibrations due to impact forces Are minimum
- Pleasing appearance.



Slab Bridge:

Simplest type of RCC slab
Generally found to be economical for a span of 9m.
The thickness of slab is quite considerable but uniform.



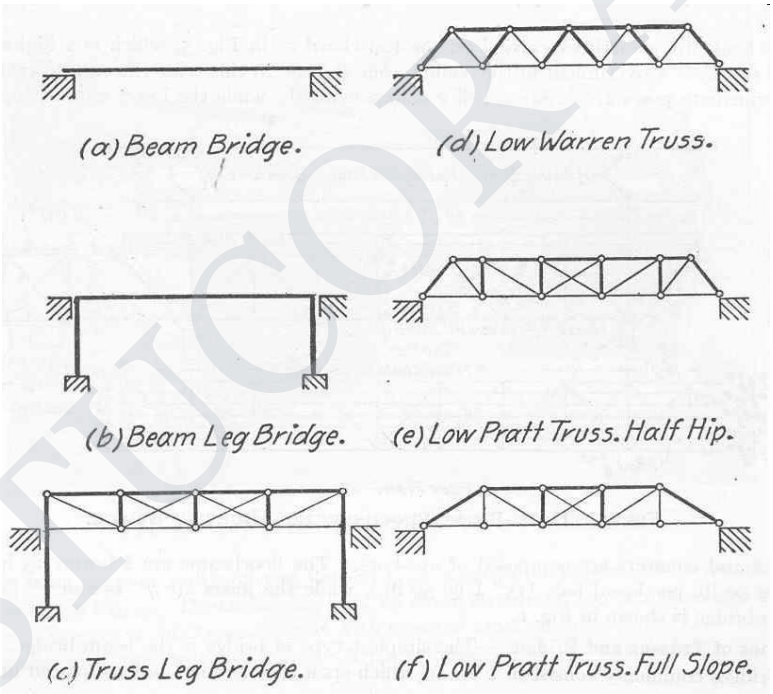
T beam and slab bridge:

It consists of T beams supported over piers and abutments.
The deck slab is supported over the T beams
It is suitable for a span of 9 – 20 m

Steel arch bridges are constructed where it is not possible to construct an intermediate pier.
It can be used for a long span upto 150 m.

Steel truss beam

It is provided for long railway bridges
These bridges are less affected by wind forces.
It is easy to erect the steel truss bridge since the component members are light in weight.



Movable bridges:

Movable bridges are constructed in Order to provide a headway to or Opening for navigation ships.
The design of bridge superstructure is done in such a way that it can be moved so as to allow necessary width and clearance for the passing of ships.

Types of movable bridges

1**. Vertical Lift bridge**

Bascule bridge

Swing Bridge

Culverts:

Culvert is a drain or water course enclosed and usually carried under a road or railway track. The following are common types of culverts.

1. Box Culvert:

It consists of one or more square or rectangular openings made of RCC or masonry. But RCC box culverts are widely used.

Pipe Culvert

It is economical for small drainage crossing.

These culverts are generally constructed for diameter less than 1.8m.

The pipes may be of Cast Iron or RCC.

If the soil is low bearing capacity, the pipes are to be bedded in a layer of concrete

Arch Culverts:

Arch culverts are constructed on brick or stone masonry or concrete walls having short spans of 2-3 m.

Depending upon loading, span and type of construction, the thickness of an arch may be 20 – 50 cm.

Roofing

Definition: A roof is the upper most part of a building which is supported on structural members and covered with roofing materials to give protection to the building against rain, wind, heat, snow etc.,

Types of roofs:

Flat Roofs

a. RCC Roof

b. Madras Terrace roof

Inclined Roofs

a. Single roof

b. Trussed roof

Flat Roofs:

RCC Roof:

It is most commonly used.

In this roof concrete with steel reinforcement bars is used to form a flat roof
It consists of RCC slab built with supporting columns. The slab is reinforced in both the principal directions.
Load carried columns are directly supported by columns

Sloping Roof:

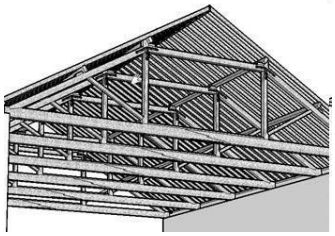
Classification:
Single roof
Double or purling roof
Trussed roof

Single Roofing:

Single Roof:
It consists of common rafters, supporting the Roofing material.
Rafters are supported at the wall plates and Rigid pieces.
Single roofs are used for spans up to 5m, So that no intermediate support is required
For rafters.

Double (Coupled) roof:
In a coupled roof a paid or coupled of Rafters slope upwards from the walls.
The rafters are kept at uniform intervals Along the length of the roof.
The rafters are connected at the upper End to a longitudinal beam.

Trussed roof:
The number of straight members are connected in the shape of triangle and forming a frame is known as truss.
Trusses are wooden framed structure, provided where there are no inside walls.
Trusses are provided at regular intervals of about 3 m long along the room length.
The spacing of trusses depend upon the load on the roof.



Flooring

Floors are horizontal elements of a building structure which divide the building into different levels for the purpose of creating more accommodation within a limited space

Types of flooring:

Mud or moorum flooring
Brick flooring
Stone flooring
Concrete flooring

Granolithic flooring Terrazzo flooring Mosaic Flooring

Marble Flooring

~~Wood or timber~~ flooring Asphalt ~~flooring Granite flooring~~

~~Industrial floorin~~t

~~Mud or moorum~~ flooring:

The floor bed should be well prepared and a 250 mm thick layer of selected moist earth is evenly spread and is rammed well so as to get a consolidated thickness of 150 mm

No water is used during ramming.

In order to prevent formation of cracks after drying, chopped straw in small quantity is mixed with the moist earth before ramming.

Upon this bed, a thin coat of cement, cowdung plaster is applied evenly and wiped clean by hand.

Brick flooring:

The sub grade is compacted properly to the desired level.

10-15cm layer of lean cement concrete or lime concrete is laid over the prepared subgrade.

This forms the base course, over which bricks are laid in desired on 12 mm thick mortar in such a way that all the joints are filled with mortar.

Brick floors are suitable for ware houses, stones and godowns or in place places where the bricks are available economically.

This floor is cheap

Stone flooring:

The subgrade is prepared by laying a 100mm to 150 mm layer of cement or lime concrete over a bed of well consolidated earth

The stone slabs may be square or rectangular usually 300x300 mm to 600x600 mm size.

The thickness of stone varies from 20 mm to 40 mm.

The selected stone should be hard, durable and uniform thickness.

Cement Concrete Flooring:

Base concrete:

The base course is laid over well compacted soil, compacted properly and levelled to a rough surface.

The base course consists of 7.5 cm to 10 cm thick cement concrete.

The top surface of the concrete base is roughly finished to develop a good bond between the base and topping

Wearing surface:

After the base has hardened, its surface is brushed with stiff broom and cleaned thoroughly.
The entire surface is divided into a square of rectangular not exceeding 2.5 cm in length.
Cement concrete is 25mm to 40 mm is then laid in alternate panels.
The top surface is beaten and made in a uniform line and level and smoothened by trowelling.

Mosaic Flooring:

Mosaic flooring is made of small pieces of broken tiles of glazed china, cement, or of marble, arranged in different patterns.
These pieces are cut to the desired shapes and sizes.
This floor is laid normally a hard bed of cement concrete.
The top surface of concrete base is cleaned and wetted.
On a small portion of the floor, a layer of rich cement, mortar is evenly spread to a thickness of 1cm and mosaic tiles are coloured and sprinkled pressed in the joints.
The process is continued for the whole is continued for the whole set, the surface is completely polished with a mosaic polishing machine.

Marble Flooring:

The flooring is laid over the prepared subgrade which is cleaned wetted and mopped properly.
A layer of cement mortar of 1:4 is spread in an average thickness of about 20 mm.
Marble slabs are laid in this bedding mortar, pressed and levelled.
The marble slabs may be rectangular and square in shape and their thickness varies out of the 20 mm to 40 mm.
The joints between two slabs must be very thin.
The cement that oozes out of the joints are cleaned.

Timber flooring:

The timber used for flooring should be well seasoned.
It should be free from knots and defects
A base course of cement concrete of 75 mm thickness is prepared.
Wooden fillet strips of size 20 mm x 40 mm are embedded in concrete to a depth about 12 mm along the short span.
Hence, they project above the level of the base course.
On these fillets timber flooring planks of 25 mm thickness are laid.

Tiled Flooring & Terrazzo flooring:

Tiled Flooring:

Tiled flooring may be used for both ground floor and upper floors.
In tiled flooring tiles made of clay or cement concrete or Glazed tiles, manufactured in different shapes and sizes are used.
Using coloured cement attractive patterns and coloured surface can be used.

Terrazzo flooring:

Terrazzo is a special type of cement concrete.
This concrete consists of white cement instead of grey cement and marble powder instead of sand and marble chips as coarse aggregate instead of stone aggregates.

Plastering

Plastering : Plastering is the process of covering the rough surfaces of walls, beams, columns and ceilings with a protective cover.This protective layer is plastic material like cement mortar or lime mortar.

Purpose of plastering:

Appearance: Plastering provides smooth, regular and clean surfaces to walls, beams, etc., to improve the appearance.
Durability : Plastering improves the durability of the exposed surfaces of walls.
Concealing defects: It conceals the defects in the workmanship. IT conceals use of inferior and porous materials in masonry walls, concrete, beams etc.,
Effect of atmospheric agencies : Plastering in external surfaces prevents damping of the walls, etc., due to atmospheric agencies like rain, sun, wind etc.,

Types of mortars used for plastering

Cement Mortar
Lime Mortar
Cement-lime mortar
Water – proof mortar.

Cement Mortar:

It is a mixture of ordinary portland cement and coarse sand in predetermined proportions.
The proportions of cement and sand depends on the nature of plastering work.
The usual mix for cement mortar for plastering varies from 1:3 for the surfaces in cntact with water to 1:4 to 1:6 for other surfaces.

Lime mortar:

Equal volumes of lime and fine sand are thoroughly mixed.
Either fat lime or poor lime may be used in lime mortar.
The mixture is ground in a mortar mill by adding required quantity of water to form a paste of required consistency and workability

Cement Lime mortar:

Cement lime mortar is prepared by first mixing cement and sand in a dry state in the requirement proportions.
Fat lime is mixed with water and is added to the cement sand mix.
The materials are thoroughly mixed till a mortar of the desired consistency and workability is obtained.

Water proof mortar:

Water proof mortar for plastering is prepared by mixing 1 part of cement with 2 parts of sand and pulverized alum at the rate of 12 kg/m^3 of sand.
Soap water is added to the dry mixture to make it water proof and to obtain required consistency and workability.

Plastering defects and precautions:

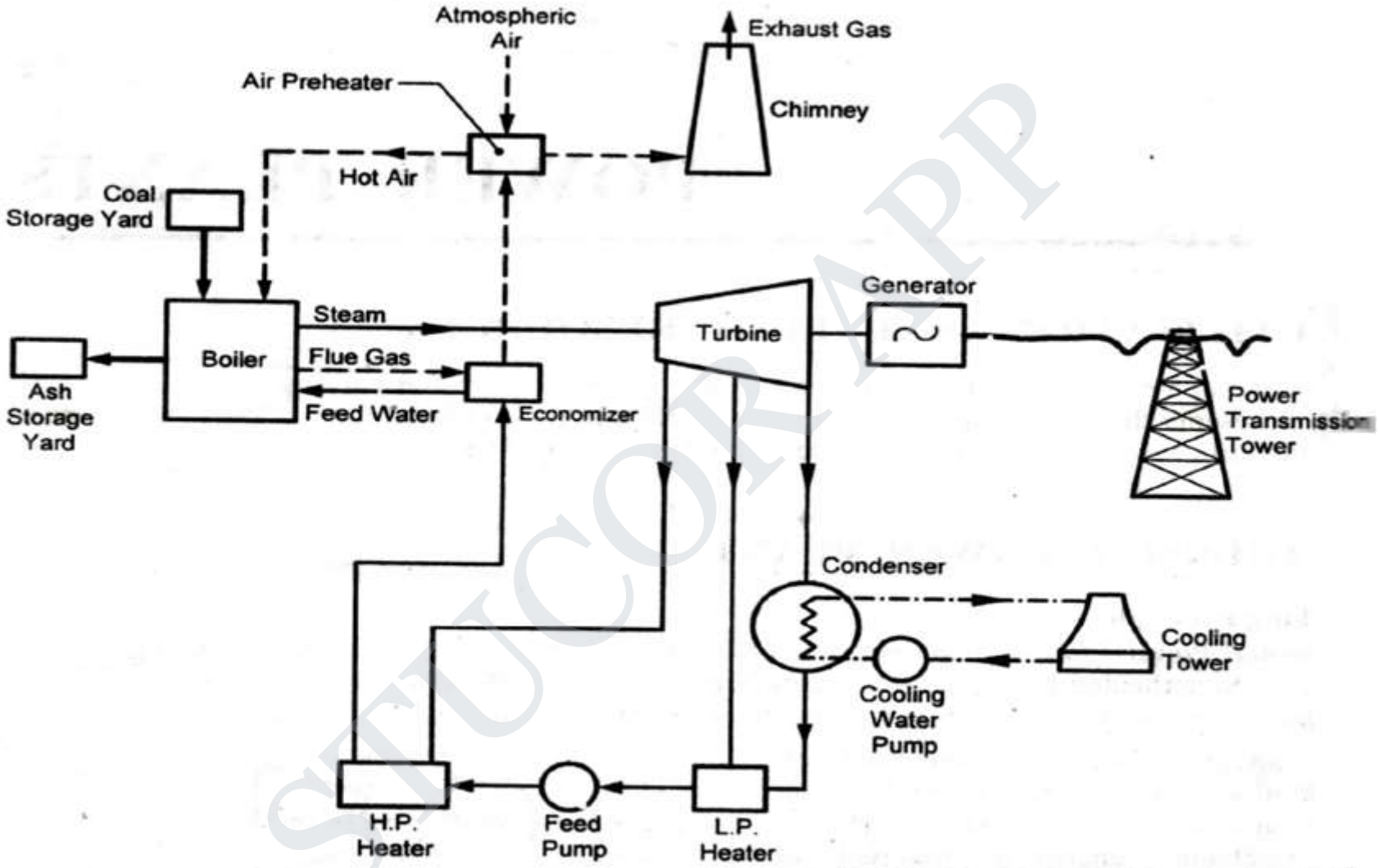
S. No.	Aspects	Defects	Remedies/Precautions
1	Crack formation	Hair line crack formation on plastered surface	Superior quality bricks should be used. Proper curing of plastered surface should be done.
2	Falling/Peeling of plaster	Patch formation on the surface of plaster and falling of plaster	Proper bonding between coats of plaster should be provided
3	Blistering	Small patches swell out beyond the plane of the plastered surface	Proper trowelling should be done.
4.	Excessive dampness	Excessive dampness at certain areas on the surface makes the portion soft	Damp proof course (DPC) should be provided in the floor roof etc.,

UNIT 4

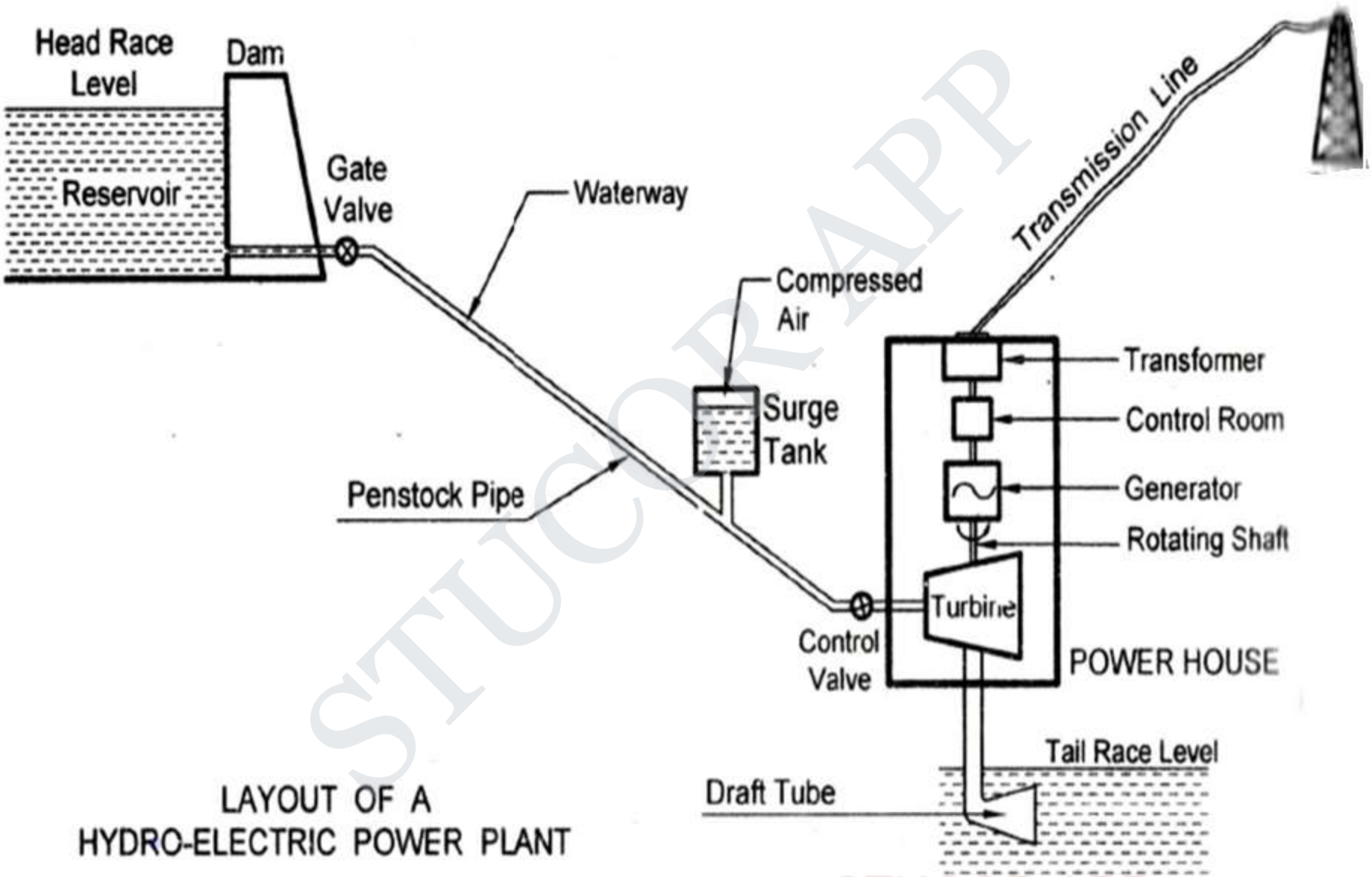
BY STUCOR

B C M E

UNIT 4

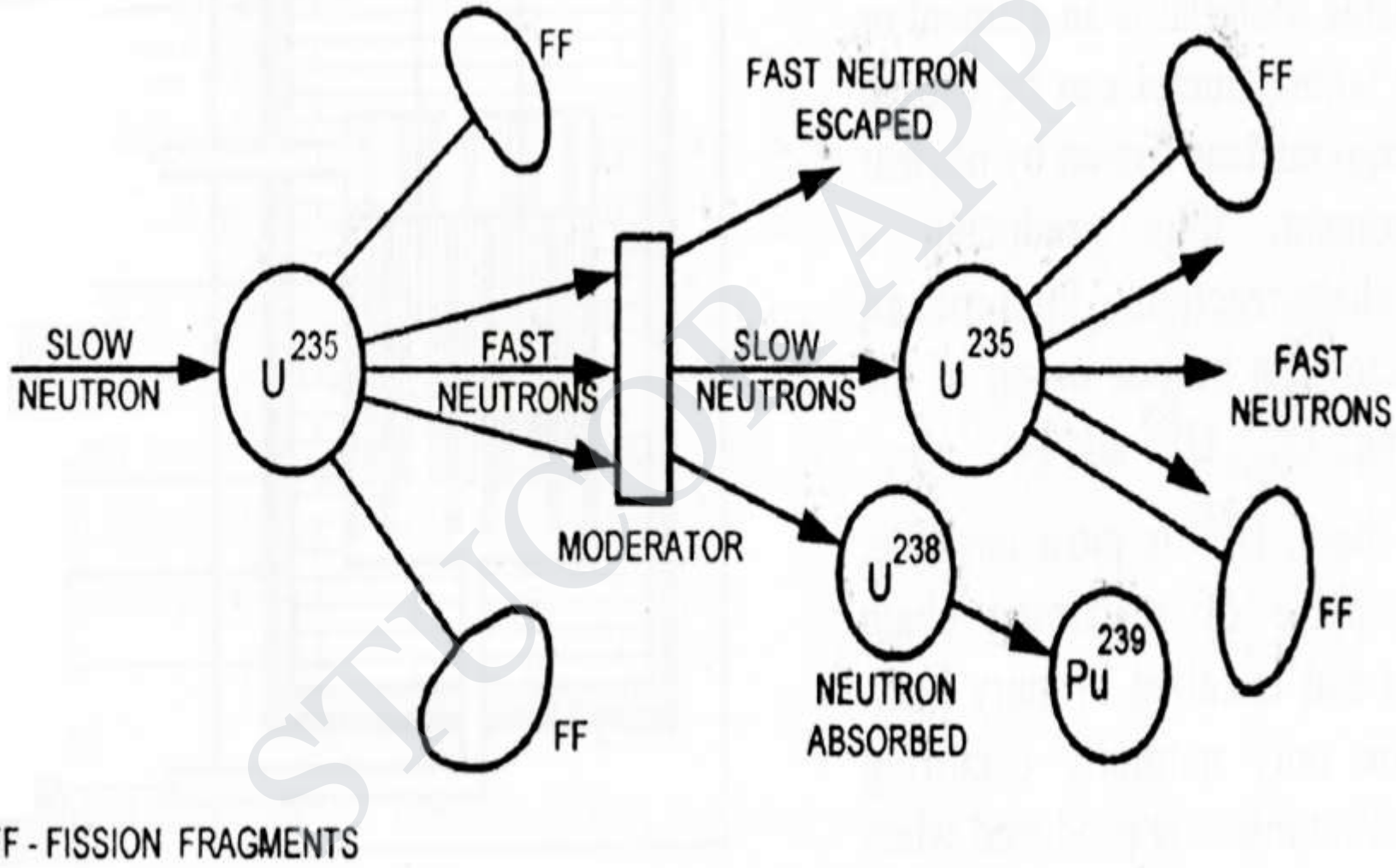


LAYOUT OF A MODERN THERMAL POWER PLANT

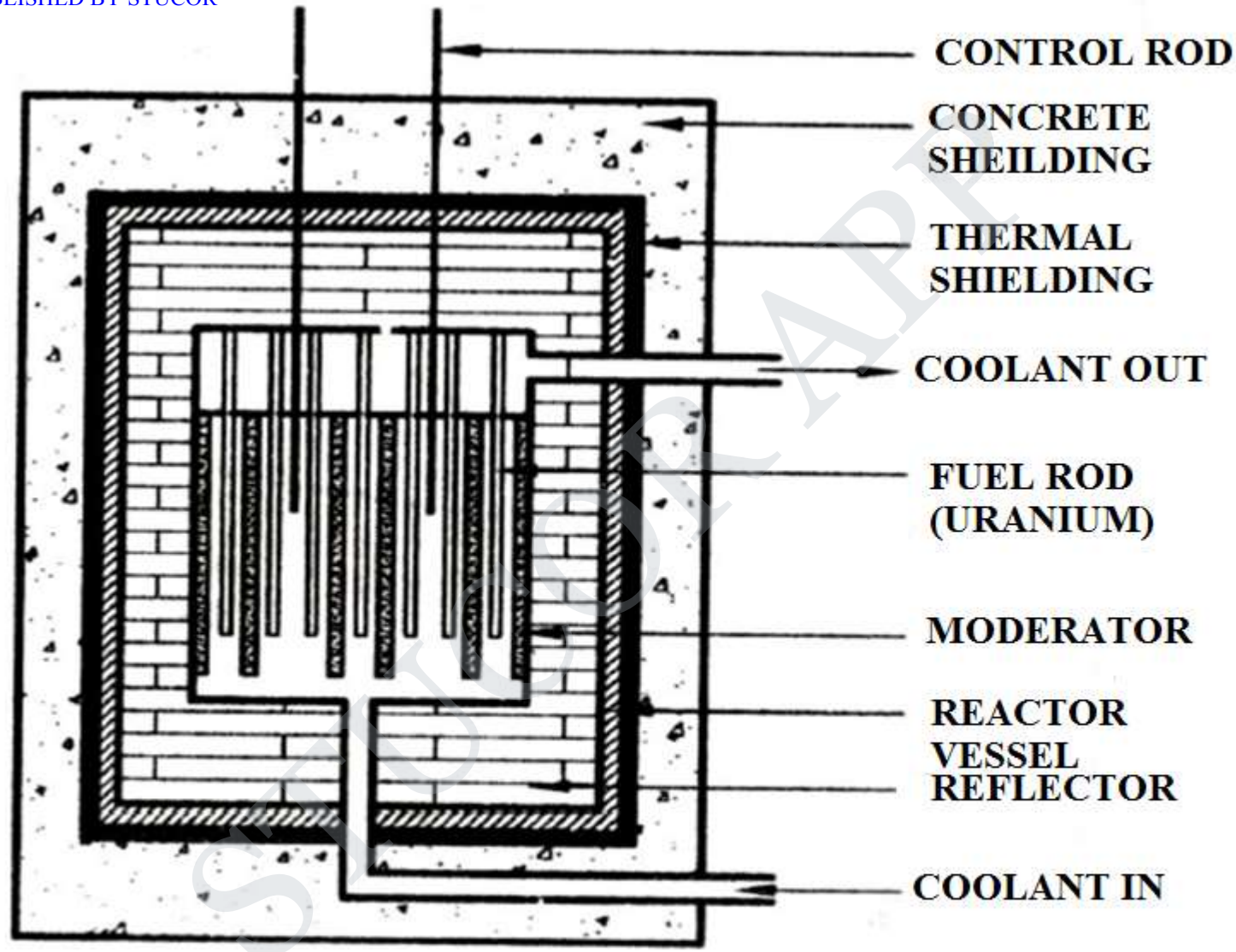


LAYOUT OF A
HYDRO-ELECTRIC POWER PLANT

NUCLEAR FISSION



NUCLEAR FISSION



NUCLEAR REACTOR

PRESSURISED WATER REACTOR (PWR)

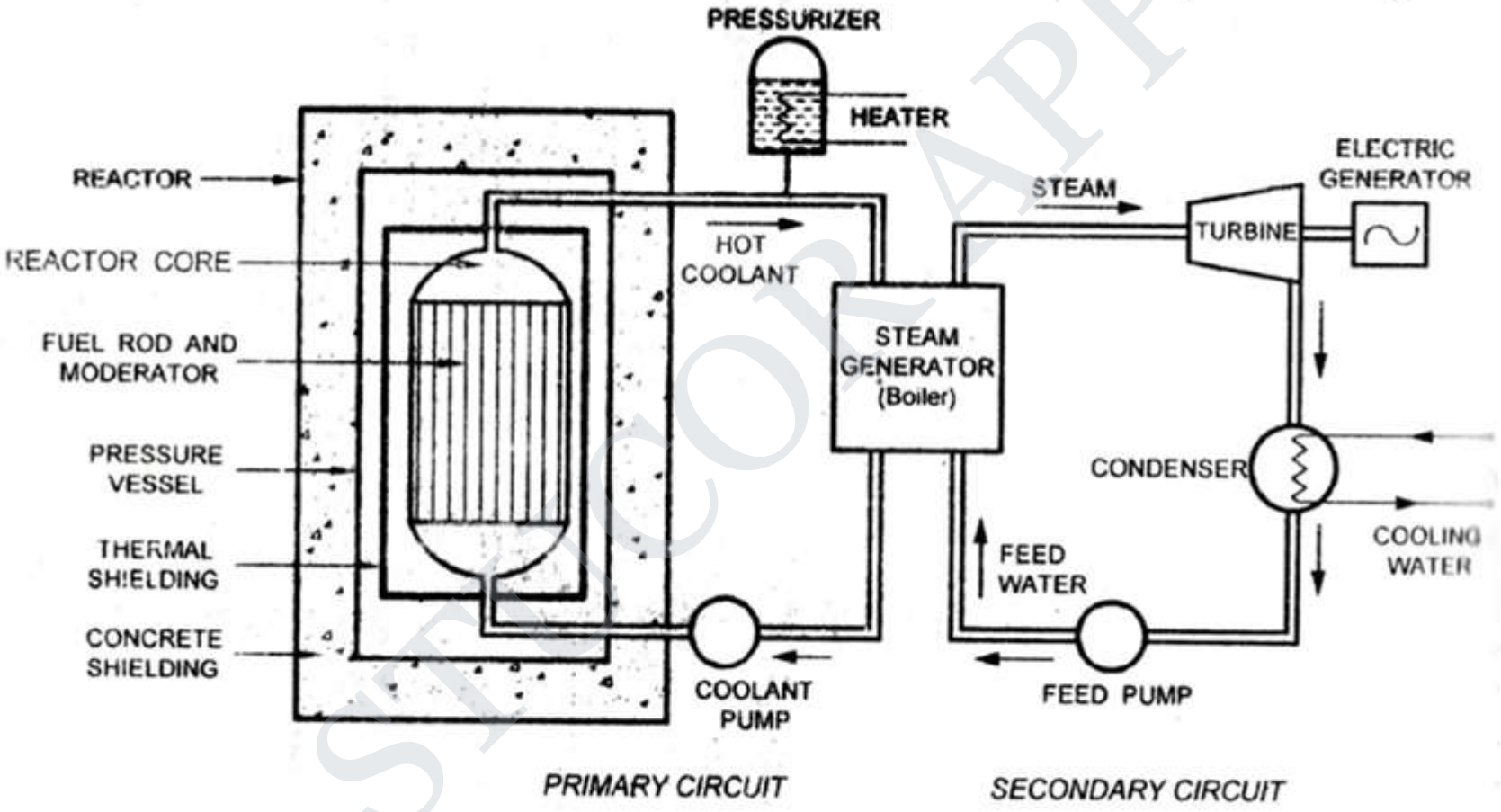
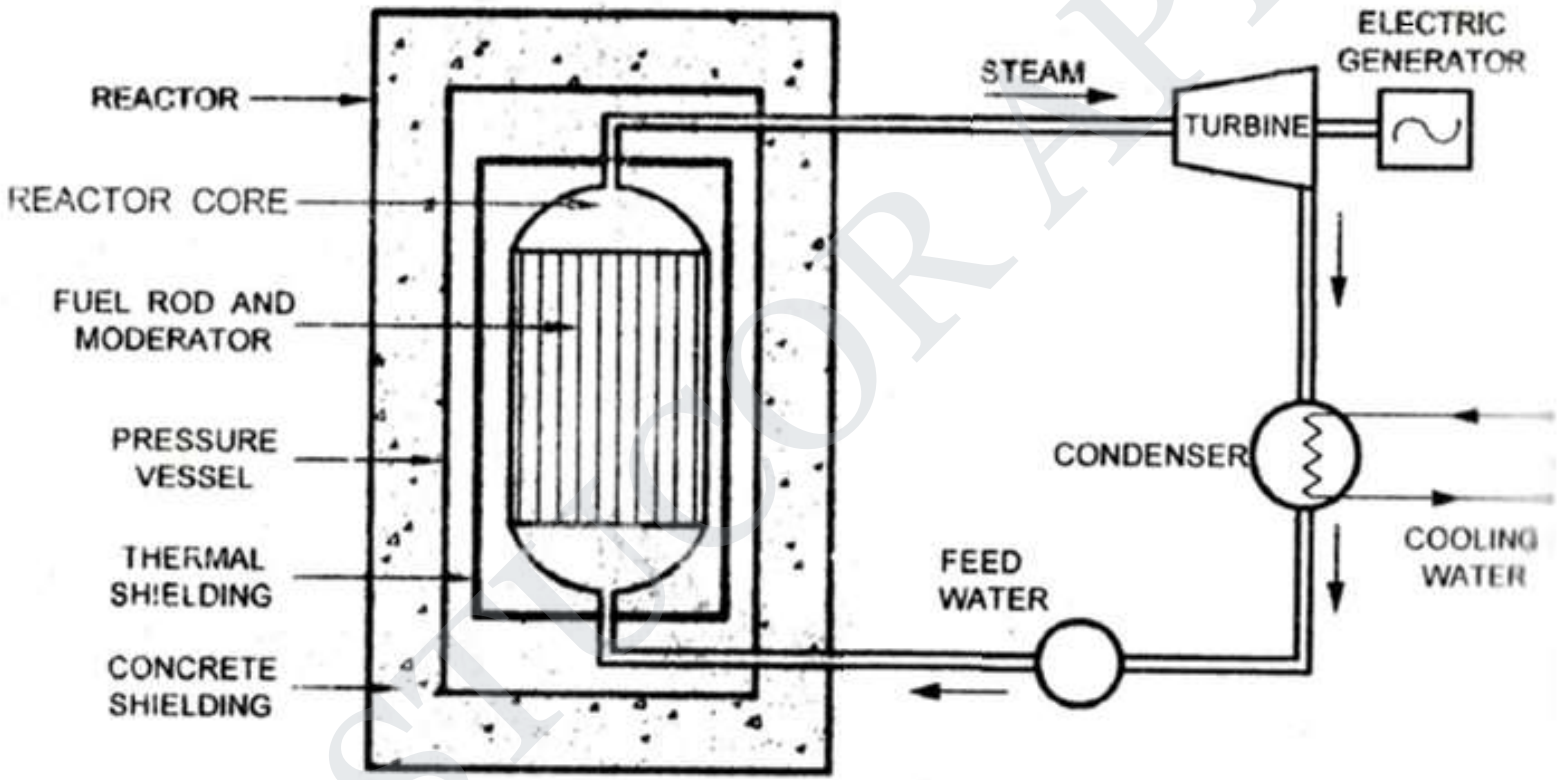


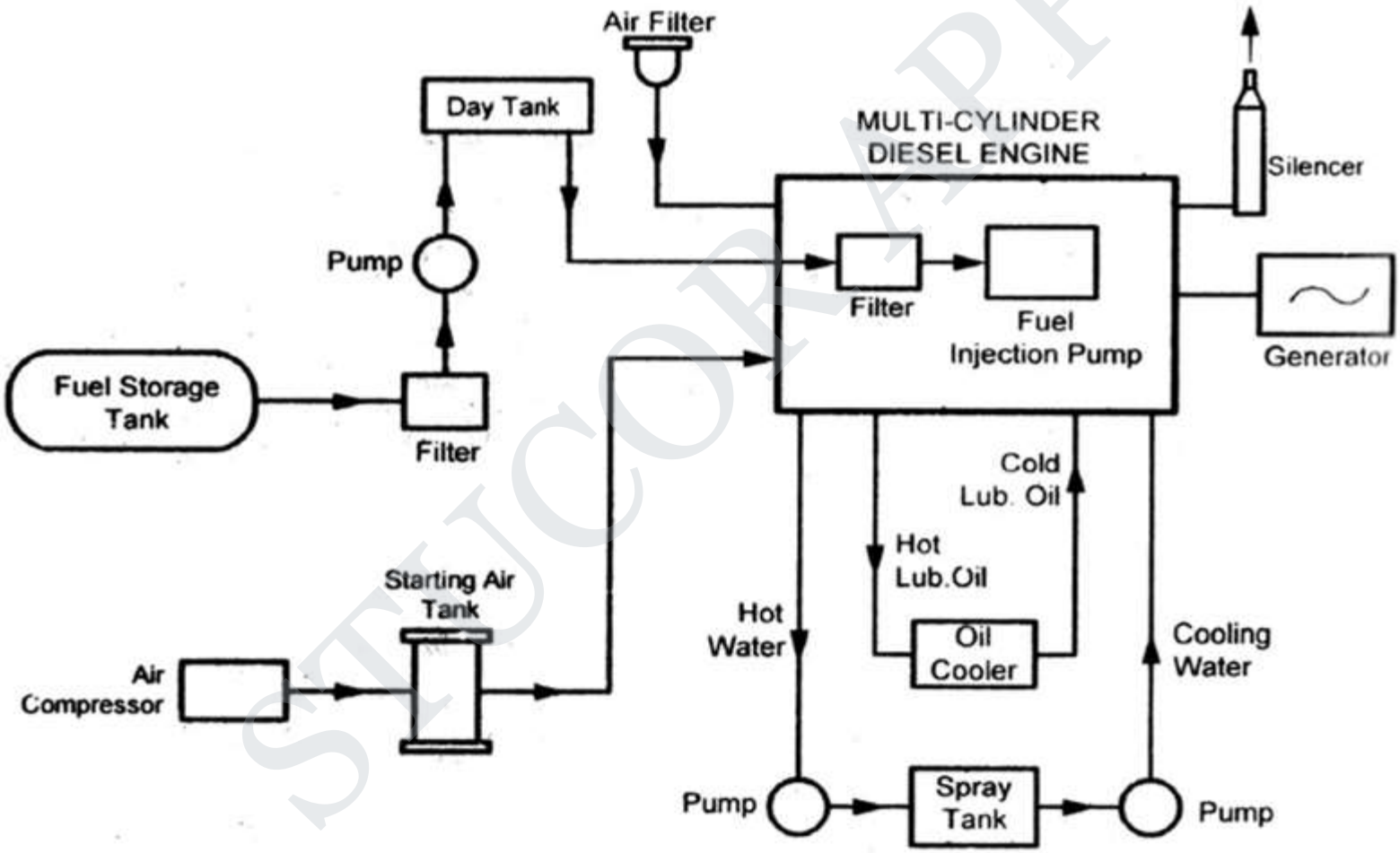
FIG. 6 LAYOUT OF NUCLEAR POWER PLANT

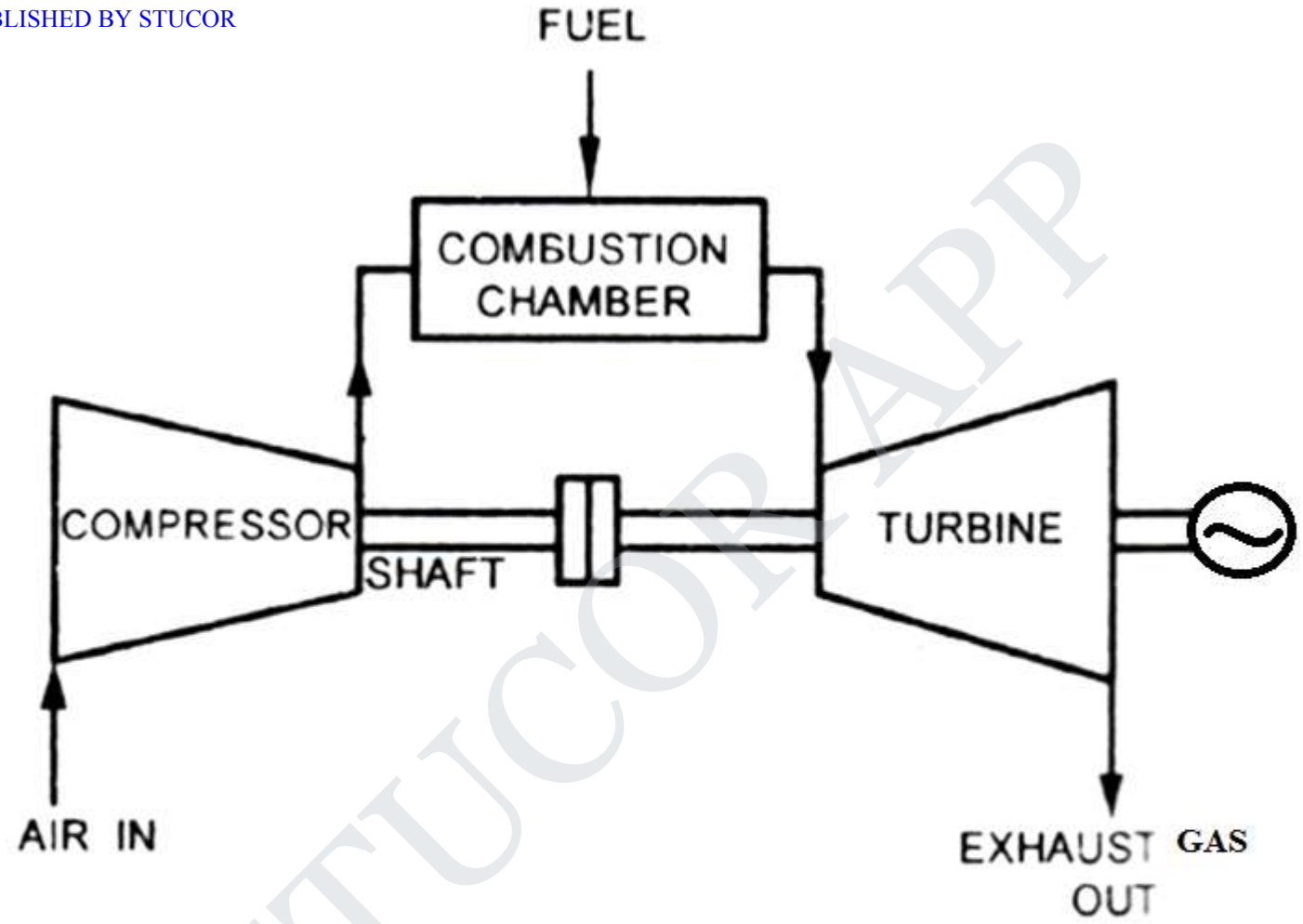
BOILING WATER REACTOR



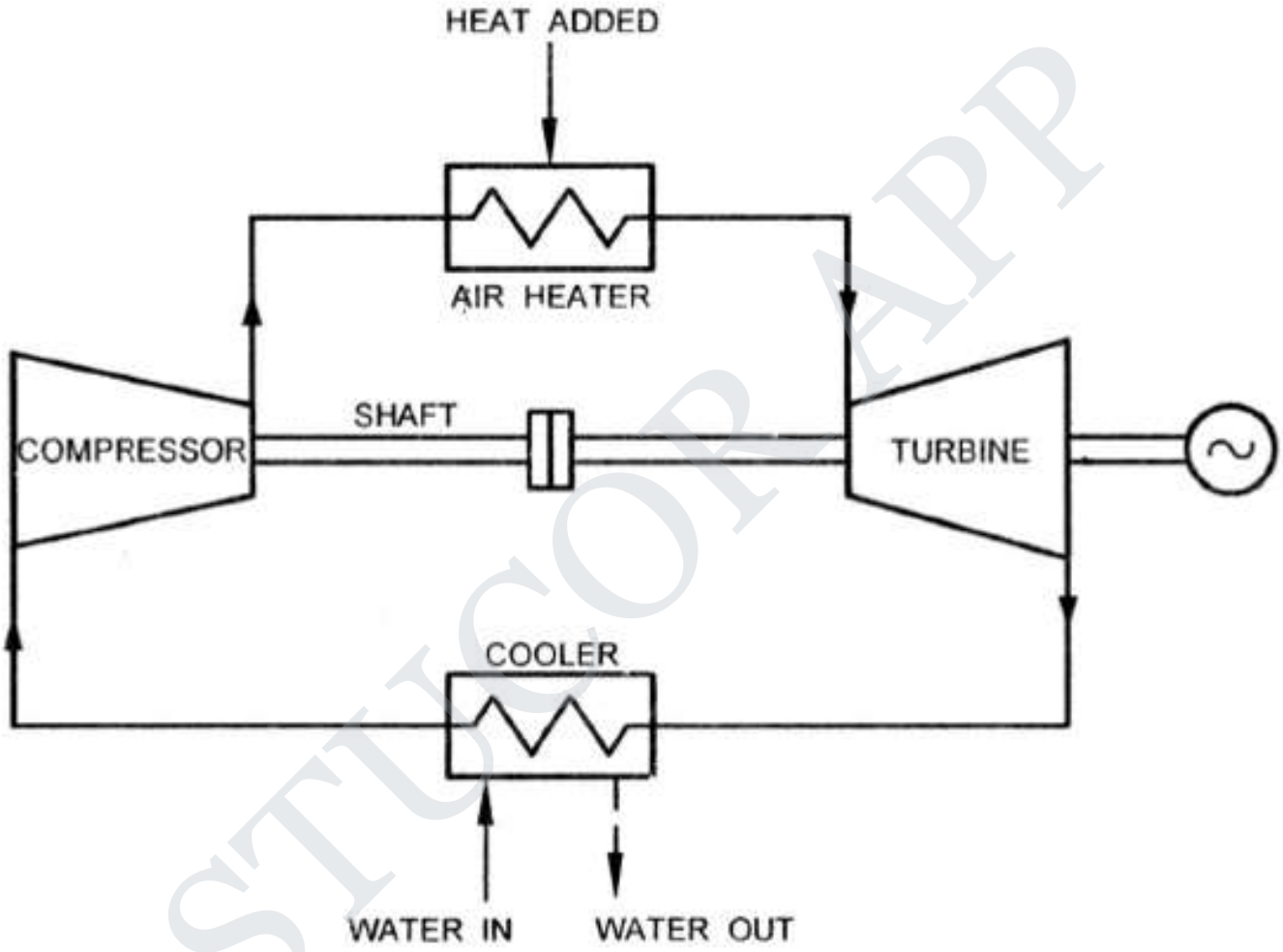
LAYOUT OF NUCLEAR POWER PLANT

DIESEL ENGINE POWER PLANT





OPEN CYCLE GAS TURBINE



CLOSED CYCLE GAS TURBINE

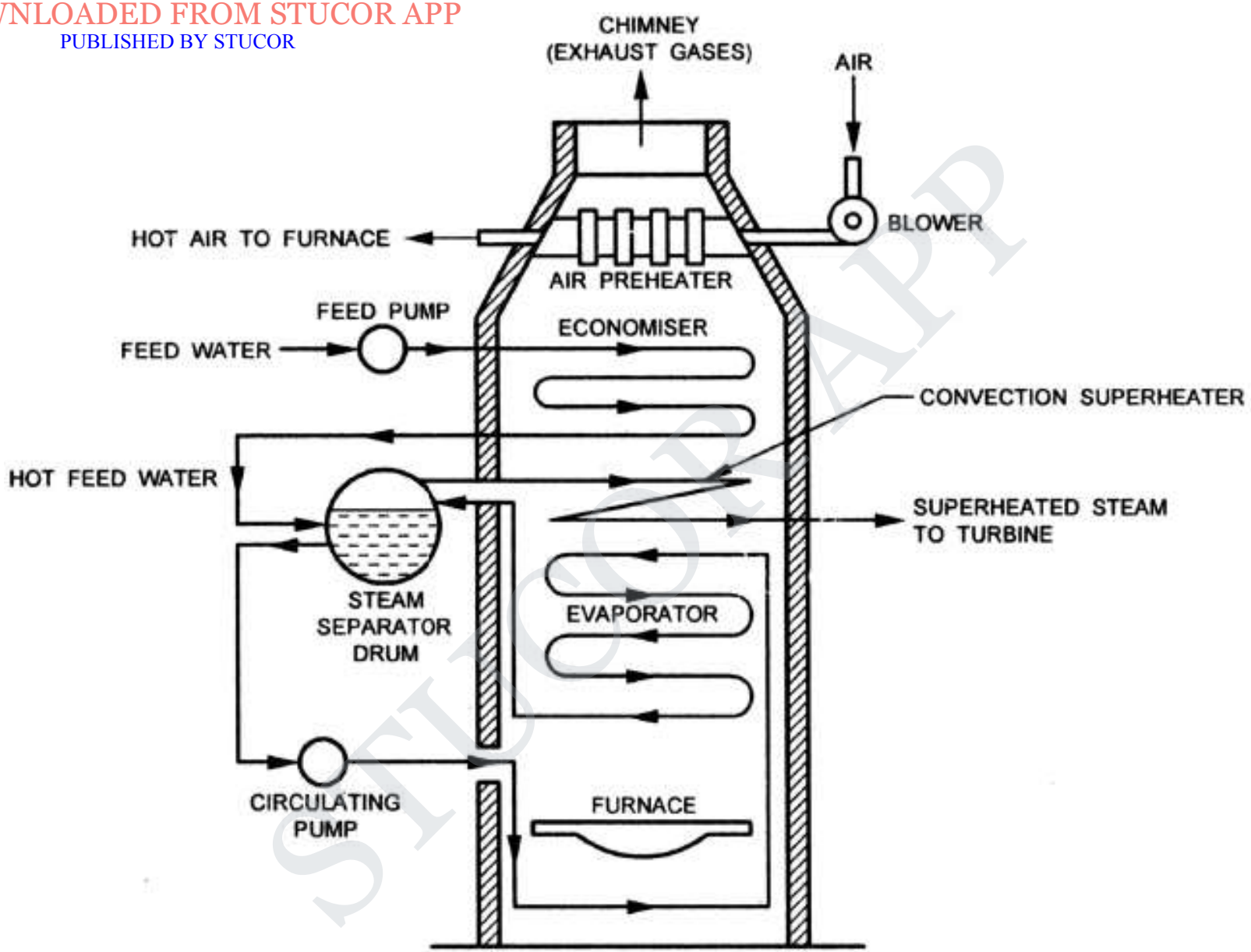


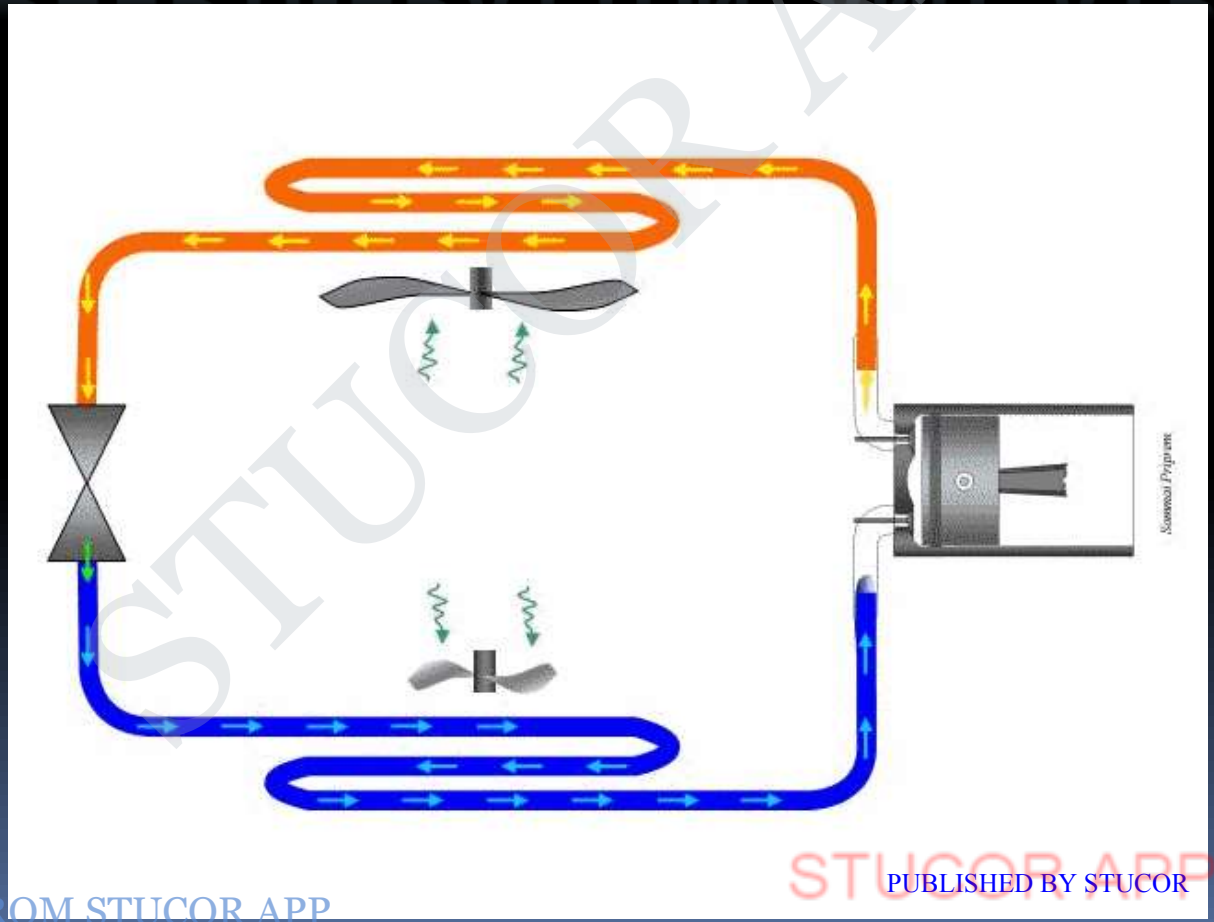
FIG. 9 HIGH PRESSURE LA-MONT BOILER

UNIT 5

BY STUCOR

UNIT V

REFRIGERATION AND AIR



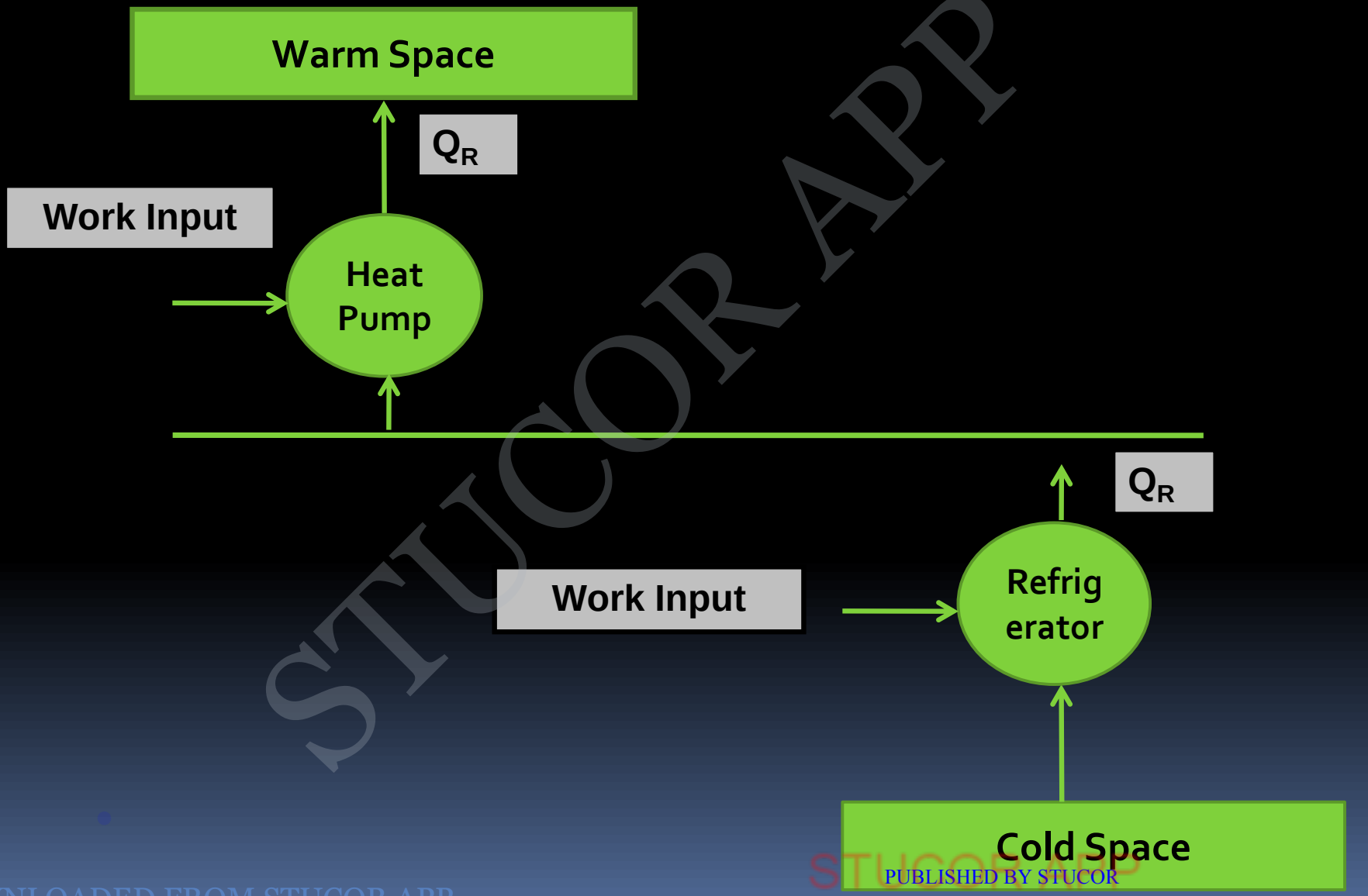
Refrigeration

- It is defined as the process of providing and maintaining a temperature well below that of surrounding atmosphere.
- In other words refrigeration is the process of cooling substance.

Refrigerators and heat pumps

- If the main purpose of the machine is to cool some object, the machine is named as refrigerator.
- If the main purpose of machine is to heat a medium warmer than the surroundings, the machine is termed as heat pump.

Refrigerator and Heat pump



Terminologies of Refrigeration

Refrigerating Effect (N): It is defined as the quantity of heat extracted from a cold body or space to be cooled in a given time.

$$N = \frac{\text{Heat extracted from the cold space}}{\text{Time taken}}$$

Specific Heat of water and ice : It is the quantity of heat required to raise or lower the temperature of one kg of water (or ice), through one kelvin or (1^0 c) in one second.

Specific heat of water, C_{pw} = 4.19 kJ/kg K

Specific heat of ice, C_{pice} = 2.1 kJ/kg K.

Terminologies of Refrigeration

Capacity of a Refrigeration Unit :

- Capacity of a refrigerating machines are expressed by their cooling capacity.
- The standard unit used for expressing the capacity of refrigerating machine is ton of refrigeration.
- One ton of refrigeration is defined as, "the quantity of heat abstracted (refrigerating effect) to freeze one ton of water into one ton of ice in a duration of 24 hours at 0^o c".

Heat extracted from at 0^o c = latent heat of ice

Latent heat of ice = 336 kJ/kg

i.e., 336 kJ of heat should be extracted from one kg of water at 0^o C to convert it into ice.

Terminologies of Refrigeration

One ton of refrigeration $= \frac{336 \times 1000 \text{ kJ}}{24 \text{ hrs.}}$

$= \frac{336 \times 1000 \text{ kJ/min}}{24 \times 60}$

One ton of refrigeration $= 233.333$ kJ/min

$= 3.8889$ kJ/sec

Terminologies of Refrigeration

Co efficient of Performance: It is defined as the ratio of heat extracted in a given time (refrigerating effect) to the work input.

$$\text{Co efficient of performance} = \frac{\text{Heat extracted in evaporator}}{\text{Work Input}}$$

$$\text{Co efficient of performance} = \frac{\text{Refrigerating Effect}}{\text{Work Input}}$$

$$\text{Co efficient of performance} = \frac{N}{W}$$

The COP is always greater than 1 and known as theoretical coefficient of performance.

Refrigerants

Refrigerant: **Any substance that absorbs heat through expansion and vaporisation process and loses heat due to condensation is a refrigeration process is called refrigerant.**

Some examples of refrigerants are,

- *Air*
- *Ammonia (NH_3)*
- *Carbon dioxide (CO_2)*
- *Sulphur dioxide (SO_2)*
- *Freon – 12*
- *Methyl Chloride*
- *Methylene chloride.*

Classification of Refrigerants

Refrigerants are classified as,

(a) Primary Refrigerants: It is a working medium which is used for cooling the substance by absorption of latent heat.

E.G Ammonia (NH_3), Carbon dioxide (CO_2), Sulphur dioxide (SO_2), Freon 12, etc.,

(b) Secondary Refrigerants: Secondary refrigerant is a substance already cooled by primary refrigerant and then employed for cooling purposes.

E.g Ice, solid carbon dioxide.

These refrigerants cool the substance by absorption of their sensible heat.

Types of Refrigerators

- **Ice Refrigerators :** Ice is kept in the cabinet of refrigerators and this acts as the refrigerating means.
- **Air Refrigerators :** Air is used as working agent in these types of refrigerators.

  E.g., Bell Coleman Cycle.
- **Vapour Refrigerators:** The working agents employed in this type of refrigerators are ammonia, CO_2, SO_2, freons etc.,

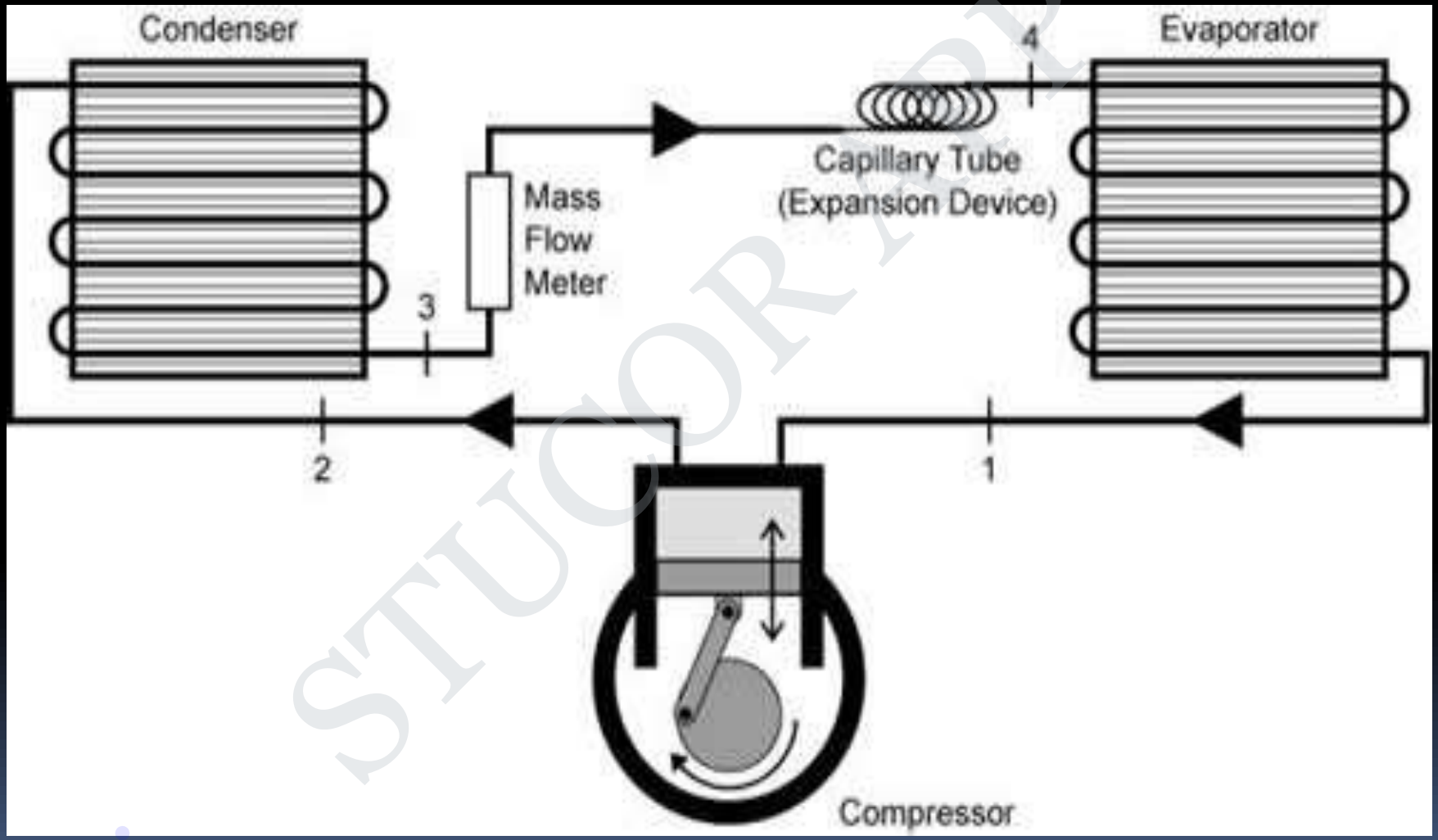
Applications of Refrigeration

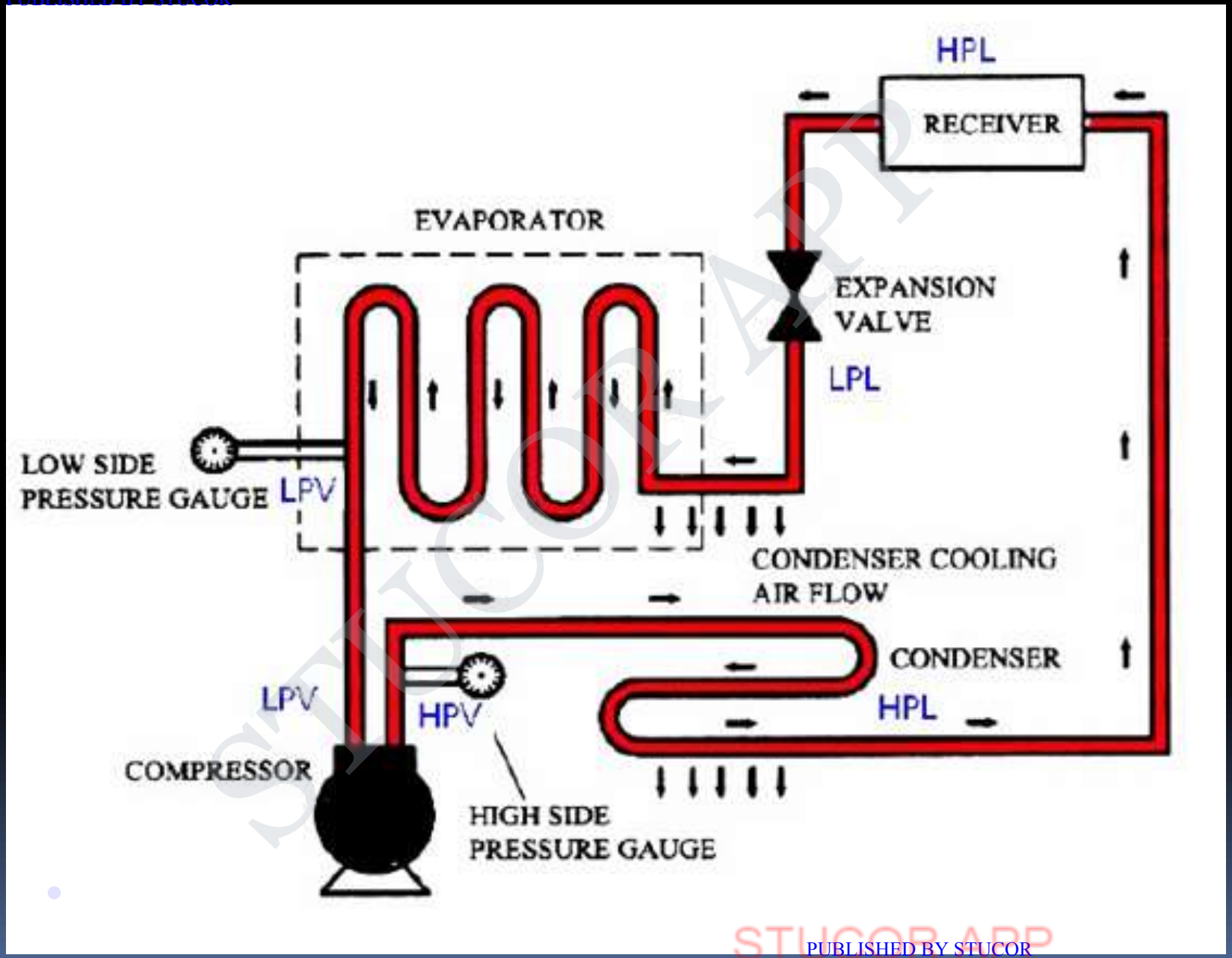
- In chemical industries, for separating and liquefying the gases.
- In manufacturing and storing ice.
- For the preservation of perishable food items in cold storages.
- For cooling water.
- For controlling humidity of air manufacture and heat treatment of steels.
- For chilling the oil to remove wax in oil refineries.
- For the preservation of tablets and medicines in pharmaceutical industries.
- For the preservation of blood tissues etc.,
- For comfort air conditioning the hospitals, theatres, etc.,

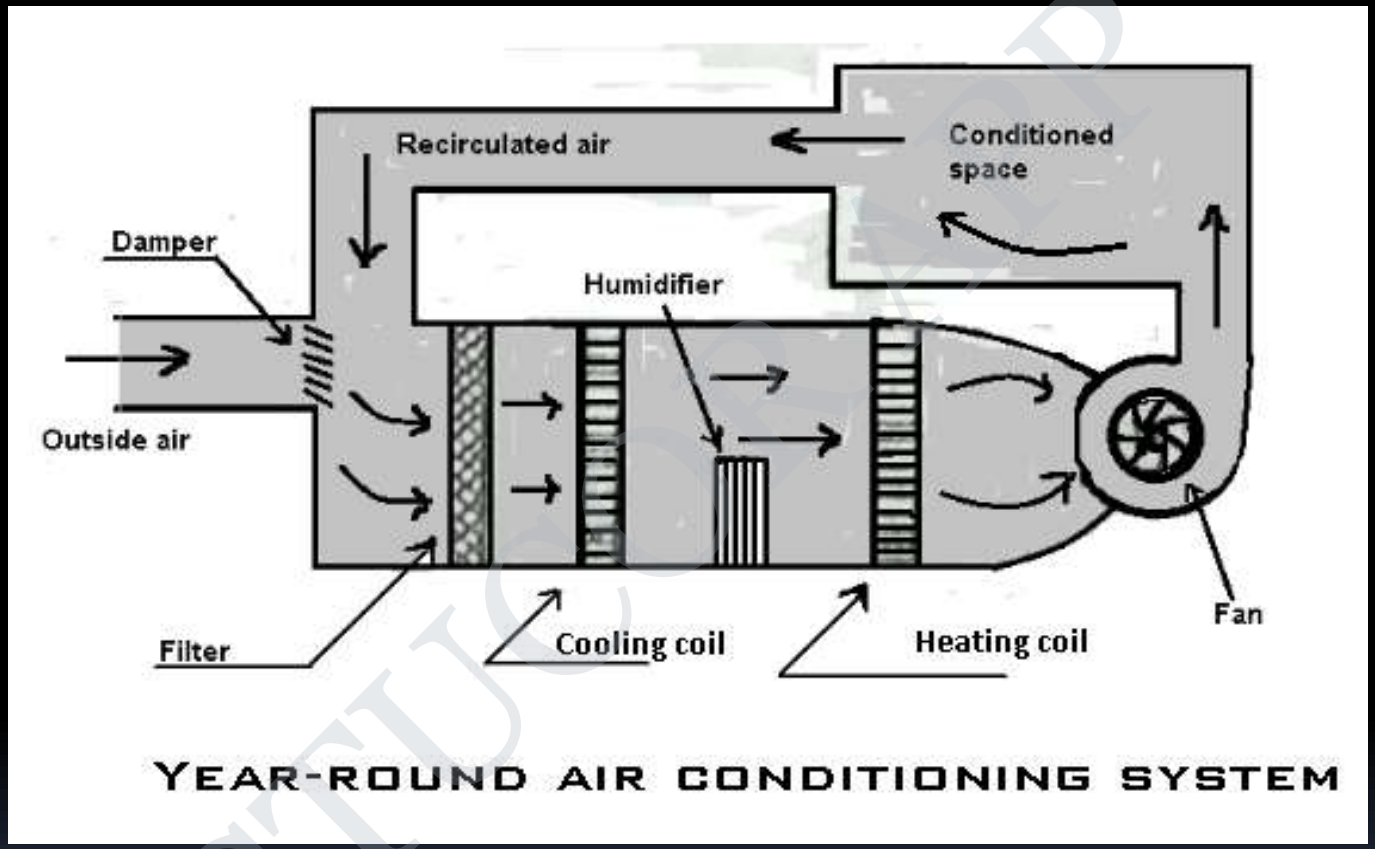
Properties of Refrigeration

- A good refrigerant should have high latent heat of vapourisation.
- It should have low boiling and low freezing point.
- It should be non toxic and should non corrosiveness
- It should be non flammable and non explosive.
- It should have high thermal conductivity
- It should be easy to handle
- It should have low specific volume of vapour.
- It should have high co efficient of performance

Vapour Compression Refrigeration System







Year-Round Air Conditioning System

Applications of air conditioning

- Used in houses, hospitals, offices, computer centres, theatres, departmental stores etc.,
- Air-conditioning of transport media such as buses, cars trains, aeroplanes and ships.
- Wide application in food processing, printing, chemical, pharmaceutical and machine tool, etc.,