POWER PLANT ENGINEERING

UNIT–I : Introduction to Power Plant

Introduction to Power Plant Engineering

1.1 Introduction

Electric power has become an essential requirement for modern life. Industries, transportation, communication, agriculture, healthcare, and domestic activities depend heavily on electrical energy. The generation of electrical energy is carried out in power plants.

Definition of Power Plant

A power plant is an industrial facility where different forms of energy such as thermal energy, hydraulic energy, nuclear energy, solar energy, wind energy, etc. are converted into electrical energy.

Power Plant Engineering

Power Plant Engineering deals with:

- Generation of electrical power
- Selection of suitable power plants
- Operation and maintenance of power plants
- Efficient utilization of fuel and resources
- Economic and environmental considerations

1.2 Need for Power Plants

The demand for electricity is increasing continuously due to:

1. Rapid industrialization
2. Urbanization
3. Agricultural development
4. Growth of transportation systems
5. Increasing domestic consumption
6. Development of information technology

1.3 Energy Conversion in Power Plants

Different power plants convert energy according to the following principle:

Energy Source	Conversion Process
Coal	Chemical → Thermal → Mechanical → Electrical
Water	Potential → Kinetic → Mechanical → Electrical
Nuclear Fuel	Nuclear → Thermal → Mechanical → Electrical
Wind	Kinetic → Mechanical → Electrical
Solar	Solar Radiation → Electrical

1.4 Objectives of a Power Plant

A good power plant should:

- Generate electricity reliably
- Operate economically
- Have high efficiency
- Ensure safety
- Minimize environmental pollution
- Meet load demand continuously

Short Questions

1. Define power plant.
2. What is Power Plant Engineering?
3. Why is electricity important?
4. State the objectives of a power plant.

Indian Energy Scenario

2.1 Introduction

India is one of the world's largest consumers of energy. Due to population growth, industrialization, and technological development, the demand for electricity is increasing rapidly.

2.2 Energy Resources in India

Energy resources are broadly classified into:

A. Conventional Energy Resources

These resources are exhaustible and have been used traditionally.

Examples:

- Coal
- Petroleum
- Natural Gas
- Large Hydropower
- Nuclear Energy

B. Non-Conventional (Renewable) Energy Resources

These resources are naturally replenished.

Examples:

- Solar Energy
- Wind Energy
- Biomass Energy
- Tidal Energy
- Geothermal Energy
- Small Hydropower

2.3 Present Power Generation Sources in India

Electricity in India is generated from:

1. Thermal Power Plants

- Coal-based
- Gas-based
- Diesel-based

Contribution: Major share of electricity generation.

2. Hydroelectric Power Plants

Generated using water stored in dams.

3. Nuclear Power Plants

Generated using nuclear fission reactions.

4. Renewable Energy Plants

- Solar power plants
- Wind farms
- Biomass plants

2.4 Challenges in Indian Energy Sector

1. Increasing energy demand
2. Depletion of fossil fuels
3. Environmental pollution
4. Transmission and distribution losses
5. Requirement of sustainable energy sources

2.5 Future Energy Strategy

India aims to:

- Increase renewable energy generation
- Improve energy efficiency
- Reduce carbon emissions
- Develop smart grids
- Promote green energy technologies

Short Questions

1. What are conventional energy resources?
2. Give examples of renewable energy sources.
3. What are the challenges of the Indian energy sector?
4. Differentiate between conventional and non-conventional energy sources.

Location of Power Plant

3.1 Introduction

The location of a power plant significantly affects its construction cost, operating cost, efficiency, and reliability.

Proper site selection is therefore very important.

3.2 Factors Affecting Location of Power Plant

1. Availability of Fuel

- Coal-fired plants should be located near coal mines.
- Reduces transportation cost.

2. Availability of Water

Large quantity of water is required for:

- Steam generation
- Cooling purposes
- Condenser operation

Hence plants are usually located near:

- Rivers
- Lakes
- Reservoirs

3. Availability of Land

Adequate land is required for:

- Plant buildings
- Fuel storage
- Ash handling
- Future expansion

4. Transportation Facilities

Good transport facilities are required for:

- Fuel transportation
- Equipment transportation
- Maintenance activities

5. Distance from Load Center

Power plants should be reasonably close to consumers to reduce:

- Transmission losses
- Transmission cost

6. Environmental Considerations

Plant location should minimize:

- Air pollution
- Noise pollution
- Water pollution

7. Availability of Labour

Skilled and unskilled labour should be available nearby.

8. Waste Disposal Facility

Particularly important for:

- Thermal power plants
- Nuclear power plants

3.3 Ideal Site Characteristics

An ideal power plant site should have:

- Adequate fuel supply
- Sufficient water supply
- Good transportation
- Suitable land
- Environmental acceptability
- Expansion possibilities

Short Questions

1. Why is water required in a thermal power plant?
2. Mention factors affecting power plant location.
3. What are the characteristics of an ideal site?

Choice of Power Plant

4.1 Introduction

Selection of a suitable power plant depends upon technical, economic, and environmental factors.

4.2 Factors Governing Choice of Power Plant

1. Availability of Fuel

- Coal available → Thermal plant
- Water available → Hydroelectric plant

2. Initial Cost

- Hydroelectric plant → High initial cost
- Thermal plant → Lower initial cost

3. Operating Cost

- Thermal plant → Higher operating cost
- Hydroelectric plant → Lower operating cost

4. Load Demand

Base Load Plant

Operates continuously.

Examples:

- Thermal plants
- Nuclear plants

Peak Load Plant

Operates during peak demand.

Examples:

- Hydroelectric plants
- Gas turbine plants

5. Availability of Water

Water availability influences plant selection.

6. Environmental Impact

Modern power plants should:

- Reduce pollution
- Improve efficiency
- Follow environmental regulations

7. Reliability

Plant must provide uninterrupted supply.

4.3 Comparison of Different Power Plants

Parameter	Thermal	Hydro	Nuclear
Initial Cost	Medium	High	Very High
Operating Cost	High	Low	Low
Construction Time	Short	Long	Long
Pollution	High	Low	Very Low
Efficiency	Moderate	High	High

Short Questions

1. What is a base load plant?
2. What is a peak load plant?
3. State factors affecting choice of power plant.
4. Compare thermal and hydroelectric power plants.

Classification of Power Plants

5.1 Classification Based on Source of Energy

A. Conventional Power Plants

1. Thermal Power Plant

Fuel Used:

- Coal
- Oil
- Natural Gas

2. Hydroelectric Power Plant

Uses energy of falling water.

3. Nuclear Power Plant

Uses nuclear fuel such as uranium.

B. Non-Conventional Power Plants

1. Solar Power Plant

Uses solar radiation.

2. Wind Power Plant

Uses wind energy.

3. Biomass Power Plant

Uses agricultural waste and organic matter.

4. Geothermal Power Plant

Uses heat from the earth.

5. Tidal Power Plant

Uses sea tides.

5.2 Classification Based on Duty

Base Load Plants

Examples:

- Thermal
- Nuclear

Peak Load Plants

Examples:

- Hydroelectric
- Gas Turbine

5.3 Classification Based on Prime Mover

Steam Power Plant

Prime mover: Steam Turbine

Gas Turbine Plant

Prime mover: Gas Turbine

Diesel Power Plant

Prime mover: Diesel Engine

Hydroelectric Plant

Prime mover: Water Turbine

Short Questions

1. Classify power plants.
2. What is a conventional power plant?
3. What is a renewable power plant?
4. Name different prime movers used in power plants.

Layout of Thermal Power Plant

6.1 Introduction

A thermal power plant converts chemical energy of coal into electrical energy.

Energy Conversion

Coal Energy

↓

Heat Energy

↓

Steam Energy

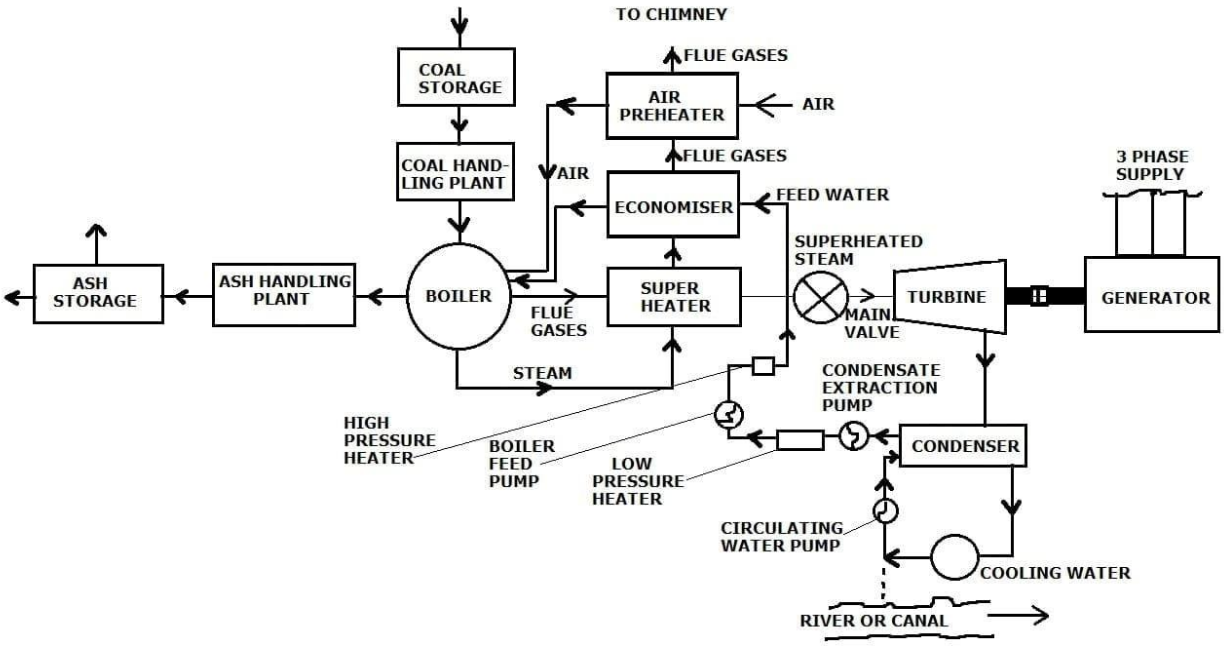
↓

Mechanical Energy

↓

Electrical Energy

6.2 Basic Layout of Thermal Power Plant



6.3 Main Components

1. Coal Handling Plant

Functions:

- Receiving coal
- Crushing coal
- Conveying coal
- Storing coal

2. Boiler

Function:

Converts water into high-pressure steam.

3. Superheater

Increases steam temperature above saturation temperature.

Advantages:

- Improves efficiency
- Reduces moisture content

4. Steam Turbine

Converts steam energy into mechanical energy.

5. Alternator

Converts mechanical energy into electrical energy.

6. Condenser

Converts exhaust steam into water.

Advantages:

- Improves efficiency
- Reuses water

7. Cooling Tower

Removes heat from cooling water.

8. Feed Water Pump

Pumps water back to the boiler.

9. Ash Handling Plant

Removes ash produced during coal combustion.

6.4 Advantages of Thermal Power Plant

- Lower initial cost
- Requires less land
- Suitable for large power generation
- Can be located near load centers

6.5 Disadvantages

- Air pollution
- High fuel cost
- Ash disposal problem
- Lower efficiency compared to some modern plants

Important Questions

1. Define power plant.
2. What is Power Plant Engineering?
3. Explain Indian energy scenario.
4. State factors affecting power plant location.
5. Explain selection criteria of power plants.
6. Classify power plants.
7. Draw layout of a thermal power plant.
8. Explain working of a thermal power plant.
9. What is the function of a condenser?
10. What is the role of a boiler in a thermal power plant?

UNIT–II: ECONOMICS OF POWER PLANT

INTRODUCTION TO POWER PLANT ECONOMICS

1.1 Introduction

Power plant economics deals with the economical generation, transmission, and distribution of electrical energy at minimum cost while maintaining reliability and quality of supply.

The main objective of power plant economics is:

- To generate electricity at the lowest possible cost.
- To utilize available resources efficiently.
- To ensure uninterrupted power supply.
- To maximize plant efficiency and profitability.

1.2 Importance of Power Plant Economics

A power plant requires huge investment in:

- Land
- Buildings
- Machinery
- Fuel
- Operation and maintenance

Therefore, economic analysis is essential for:

- Plant selection
- Plant operation
- Tariff determination
- Load management

1.3 Economic Factors of a Power Plant

Fixed Costs

These costs remain constant irrespective of plant output.

Examples:

- Interest on capital investment
- Insurance
- Taxes

- Salaries of permanent staff
- Depreciation

Variable Costs

These costs vary with electricity generation.

Examples:

- Fuel cost
- Lubricating oil cost
- Water charges
- Maintenance cost

Total Cost of Generation

$$\text{Total Cost} = \text{Fixed Cost} + \text{Variable Cost}$$

Short Questions

1. Define power plant economics.
2. What are fixed costs?
3. What are variable costs?
4. Why is economic analysis important in power plants?

TERMINOLOGY USED IN POWER PLANTS

2.1 Connected Load

The sum of rated capacities of all electrical equipment connected to the system.

Example

- Fan = 100 W
- Light = 60 W
- Heater = 1000 W

Connected Load

= 100 + 60 + 1000

= 1160 W

2.2 Maximum Demand

The highest demand recorded during a specified period.

Example

A factory consumes:

- Average load = 300 kW
- Maximum demand = 500 kW

Then maximum demand = 500 kW

2.3 Demand Factor

$$\text{Demand Factor} = \text{Maximum Demand} / \text{Connected Load}$$

Demand factor is always less than 1.

2.4 Diversity Factor

Diversity Factor = Sum of Individual Maximum Demands/ Maximum Demand of Entire System

Diversity factor is always greater than 1.

2.5 Plant Capacity

Maximum power output that a plant can produce.

Unit: MW

Short Questions

1. Define connected load.
2. Define maximum demand.
3. What is demand factor?
4. What is diversity factor?

PEAK LOAD, BASE LOAD AND LOAD CURVE

3.1 Base Load

The minimum load that exists continuously on a power system throughout the day.

Examples

- Street lighting
- Hospitals
- Essential industries

3.2 Peak Load

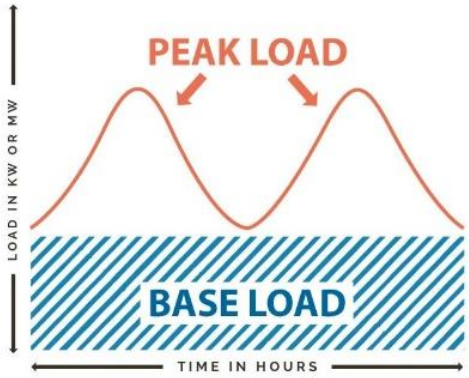
The additional load above base load occurring during certain periods.

Peak Hours

Usually:

- Morning
- Evening

Graphical Representation



3.3 Load Curve

A load curve is a graph showing variation of load with respect to time.

Importance

- Plant capacity selection
- Economic operation
- Determination of load factor
- Future planning

Types of Load Curves

Daily Load Curve

Variation of load during 24 hours.

Monthly Load Curve

Variation over one month.

Annual Load Curve

Variation throughout a year.

Short Questions

1. Define base load.
2. Define peak load.
3. What is load curve?
4. State the importance of load curve.

LOAD FACTOR AND CAPACITY FACTOR

4.1 Average Load

$$\textbf{Average Load} = \text{Energy Generated} / \text{Time}$$

4.2 Load Factor

Load factor is the ratio of average load to maximum demand.

Formula

$$\textbf{Load Factor} = \text{Average Load} / \text{Maximum Demand}$$

OR

$$\textbf{Load Factor} = \text{Energy Generated} / \{\text{Maximum Demand} \times \text{Time}\}$$

Significance

Higher load factor means:

- Better plant utilization
- Lower generation cost
- Higher efficiency

4.3 Capacity Factor

Capacity Factor= Average Load/ Plant Capacity

4.4 Utilization Factor

Utilization Factor= Maximum Demand/ Plant Capacity

Numerical Example

Plant Capacity = 100 MW

Maximum Demand = 80 MW

Average Load = 60 MW

Load Factor= 60/ 80 =0.75 = 75%

Capacity Factor= 60/ 100 = 0.60 = 60%

Short Questions

1. Define load factor.
2. Why is high load factor desirable?
3. Define capacity factor.
4. Define utilization factor.

FACTORS AFFECTING OPERATION OF POWER PLANT

5.1 Introduction

The performance and economics of power plants are affected by various technical and operational factors.

5.2 Major Factors

1. Load Demand

Variation in load affects:

- Fuel consumption
- Efficiency
- Operating cost

2. Fuel Quality

Poor quality fuel causes:

- Incomplete combustion
- Lower efficiency
- Higher maintenance cost

3. Availability of Water

Water is required for:

- Steam generation
- Cooling

Insufficient water affects plant operation.

4. Maintenance

Regular maintenance:

- Reduces breakdowns
- Improves reliability

5. Plant Efficiency

Higher efficiency results in:

- Lower fuel consumption
- Lower generation cost

6. Environmental Regulations

Plants must comply with pollution control norms.

7. Weather Conditions

Weather affects:

- Cooling efficiency
- Renewable energy generation

Short Questions

1. State factors affecting power plant operation.
2. How does fuel quality affect plant performance?
3. Why is maintenance important?

METHODS OF MEETING FLUCTUATING LOAD

6.1 Introduction

Electrical demand varies continuously.

Power plants must meet these variations economically.

6.2 Methods

Method 1: Use of Base Load Plants

Operate continuously.

Examples:

- Thermal plants
- Nuclear plants

Advantages:

- High efficiency
- Lower cost per unit

Method 2: Use of Peak Load Plants

Operate during peak demand.

Examples:

- Hydroelectric plants
- Gas turbine plants

Advantages:

- Quick starting
- Flexible operation

Method 3: Interconnected Power Systems

Several generating stations are connected together.

Benefits:

- Better reliability
- Reduced reserve capacity
- Improved economy

Method 4: Energy Storage Systems

Examples:

- Pumped storage plants
- Battery storage

Store energy during low demand and supply during peak demand.

Short Questions

1. Why does load fluctuate?
2. What are peak load plants?
3. What are base load plants?
4. State advantages of interconnected systems.

LOAD SHARING AND COST OF POWER

7.1 Load Sharing

Load sharing means distribution of electrical load among different generating stations.

Advantages

- Improved reliability
- Better efficiency
- Lower operating cost
- Reduced reserve requirement

Example

Suppose total demand = 300 MW

Thermal Plant = 200 MW

Hydro Plant = 100 MW

Load is shared according to economics and availability.

7.2 Cost of Electrical Energy

Cost of power generation includes:

Fixed Cost

- Interest
- Taxes
- Insurance
- Depreciation

Operating Cost

- Fuel
- Water
- Labour
- Maintenance

Cost per Unit

Cost per Unit= Total Annual Cost/ Annual Energy Generated

Unit = ₹/kWh

Factors Affecting Cost of Power

- Fuel price
- Plant efficiency
- Load factor
- Maintenance cost
- Capital investment

Short Questions

1. What is load sharing?
2. State advantages of load sharing.
3. Define cost of electrical energy.
4. What factors affect generation cost?

TARIFF METHODS AND PERFORMANCE CHARACTERISTICS

8.1 Tariff

Tariff is the rate charged to consumers for electrical energy supplied.

Characteristics of Good Tariff

A good tariff should:

- Recover total cost
- Provide reasonable profit
- Be simple
- Encourage efficient energy use

8.2 Tariff Methods

1. Simple Tariff

Single rate per kWh.

Example:

₹6 per kWh

2. Flat Rate Tariff

Different rates for different categories.

Example:

- Domestic = ₹5/kWh
- Industrial = ₹7/kWh

3. Block Rate Tariff

Rate decreases with increase in consumption.

Example:

First 100 units = ₹6/unit

Next 100 units = ₹5/unit

Above 200 units = ₹4/unit

4. Two-Part Tariff

$$\textbf{Total Charge} = (A \times \text{Maximum Demand}) + (B \times \text{Energy Consumed})$$

Where,

A = Demand charge

B = Energy charge

5. Three-Part Tariff

$$\textbf{Total Charge} = A+B+C$$

Where:

A = Fixed charge

B = Demand charge

C = Energy charge

Performance and Operating Characteristics

Reliability

Ability to supply power continuously.

Availability

Percentage of time plant remains operational.

$$\textbf{Availability} = (\text{Operating Time} / \text{Total Time}) \times 100$$

Efficiency

$$\textbf{Efficiency} = (\text{Output} / \text{Input}) \times 100$$

Higher efficiency means lower fuel consumption.

Plant Heat Rate

Heat energy required to generate one kWh of electricity.

Lower heat rate indicates better performance.

IMPORTANT UNIVERSITY / DIPLOMA EXAMINATION QUESTIONS

Short Questions (2 Marks)

1. Define base load.
2. Define peak load.
3. What is load factor?
4. Define capacity factor.
5. What is a load curve?
6. Define tariff.
7. What is load sharing?
8. Define maximum demand.

Long Questions (5–10 Marks)

1. Explain load curve and its significance.
2. Derive and explain load factor and capacity factor.
3. Discuss factors affecting operation of power plants.
4. Explain methods of meeting fluctuating load demand.
5. Discuss load sharing among power plants.
6. Explain various tariff methods with suitable examples.
7. Explain performance and operating characteristics of power plants.
8. Discuss economics of power generation and factors affecting cost of electricity.

UNIT–III : HYDROELECTRIC POWER PLANT

INTRODUCTION TO HYDROELECTRIC POWER PLANT

1.1 Introduction

A hydroelectric power plant converts the potential energy of stored water into electrical energy.

Water stored at a higher elevation possesses potential energy. When released through turbines, the potential energy is converted into kinetic energy and then into mechanical energy. The generator converts the mechanical energy into electrical energy.

1.2 Principle of Hydroelectric Power Generation

Energy Conversion

Potential Energy of Water
↓
Kinetic Energy
↓
Mechanical Energy (Turbine)
↓
Electrical Energy (Generator)

1.3 Importance of Hydroelectric Power

- Renewable source of energy
- No fuel cost
- Environment friendly
- Long operating life
- High efficiency (80–90%)

1.4 Essential Requirements

For hydroelectric generation:

1. Adequate water supply
2. Sufficient head (height difference)
3. Suitable storage facility
4. Suitable terrain

1.5 Components of Water Power

Head (H)

Vertical distance between water surface and turbine.

Unit: Meter (m)

Discharge (Q)

Quantity of water flowing per second.

Unit: m^3/s

Power Developed

$$P = \rho g Q H \eta$$

Where,

P = Power (W)

ρ = Density of water (1000 kg/m^3)

g = 9.81 m/s^2

Q = Discharge (m^3/s)

H = Head (m)

η = Efficiency

Short Questions

1. Define hydroelectric power plant.
2. Explain energy conversion in hydro plants.
3. What is head?
4. What is discharge?

RAINFALL AND RUNOFF

2.1 Rainfall

Rainfall is the precipitation of water from clouds in the form of rain.

It is the primary source of water for hydroelectric plants.

2.2 Measurement of Rainfall

Rainfall is measured using a:

Rain Gauge

Unit: Millimeter (mm)

Types of Rain Gauges

1. Non-recording rain gauge
2. Recording rain gauge

2.3 Runoff

Runoff is the part of rainfall that flows over the land surface and reaches streams, rivers, and reservoirs.

Factors Affecting Runoff

Climatic Factors

- Rainfall intensity
- Rainfall duration
- Temperature
- Evaporation

Physiographic Factors

- Soil condition
- Land slope
- Vegetation
- Catchment area

Runoff Measurement

Measured in:

$$m^3/s$$

using:

- Stream gauges
- Weirs
- Current meters

Runoff Cycle

Rainfall
↓
Infiltration
↓
Surface Flow
↓
River
↓
Reservoir

Short Questions

1. Define rainfall.
2. What is runoff?
3. Name different types of rain gauges.
4. Mention factors affecting runoff.

HYDROGRAPH

3.1 Definition

A hydrograph is a graph showing variation of river discharge with time.

Hydrograph Components

Rising Limb

Represents increasing discharge due to rainfall.

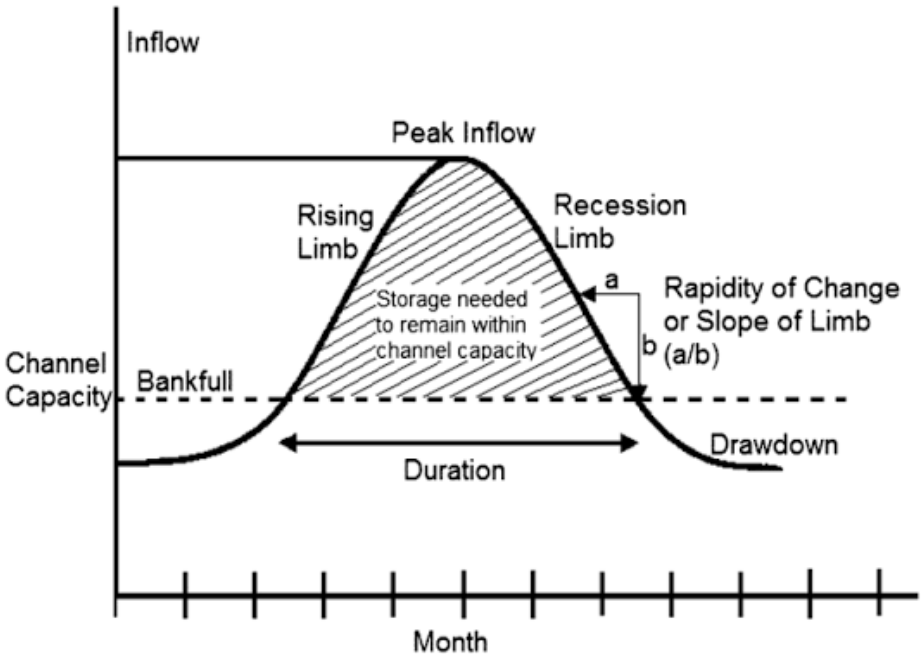
Peak Point

Maximum discharge attained.

Falling Limb

Represents reduction in discharge after rainfall stops.

Hydrograph Diagram



Importance of Hydrograph

- Reservoir design
- Flood forecasting
- Water resource planning
- Hydroelectric plant design

Short Questions

1. Define hydrograph.
2. What is rising limb?
3. What is falling limb?
4. State uses of hydrograph.

FLOW DURATION CURVE

4.1 Definition

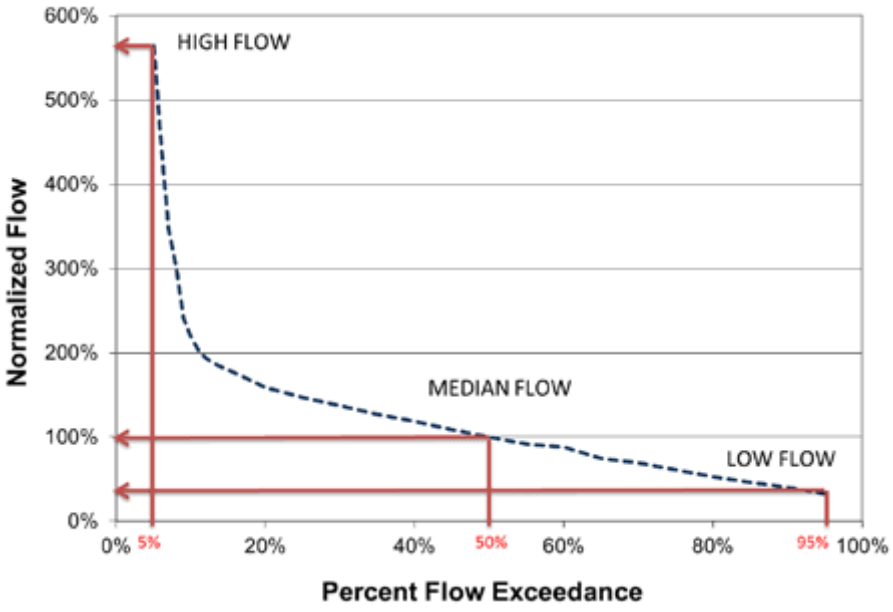
Flow Duration Curve (FDC) is a graph showing the percentage of time a given flow rate is equalled or exceeded.

Purpose

Used to determine:

- Firm power
- Secondary power
- Plant capacity
- Reservoir requirements

Flow Duration Curve



Advantages

- Indicates stream flow characteristics.
- Helps estimate power generation.
- Assists in plant design.

Limitations

- Does not indicate chronological sequence.
- Does not represent flood conditions accurately.

Short Questions

1. Define flow duration curve.
2. State its importance.
3. Mention advantages of FDC.

SELECTION OF SITE FOR HYDROELECTRIC POWER PLANT

5.1 Introduction

Proper site selection is essential for economical and efficient operation.

Factors Affecting Site Selection

1. Availability of Water

Continuous water supply throughout the year.

2. Adequate Head

Higher head increases power generation.

3. Storage Capacity

Large reservoir should be possible.

4. Geological Conditions

Strong foundation for:

- Dam
- Power house

5. Accessibility

Good transportation facilities.

6. Distance from Load Center

Shorter transmission distance preferred.

7. Environmental Impact

Minimum effect on:

- Forests
- Wildlife
- Human settlements

8. Future Expansion

Provision for future capacity increase.

Characteristics of Ideal Site

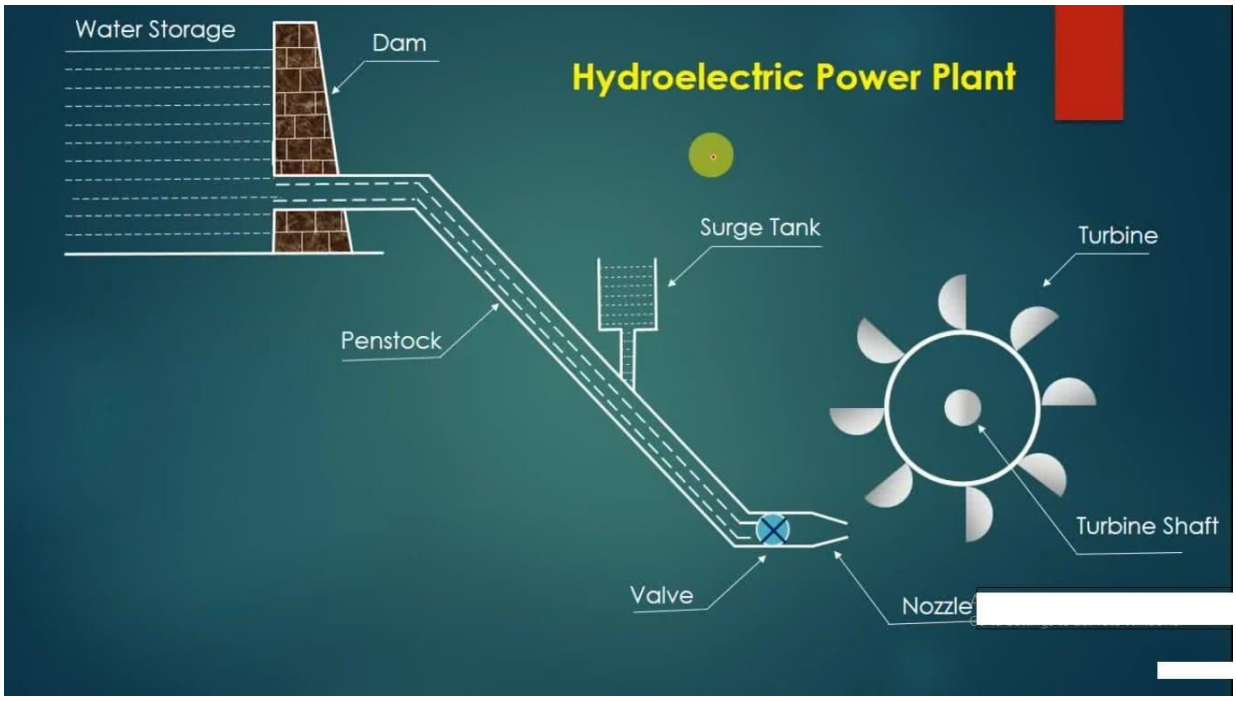
- Abundant water supply
- High head
- Strong foundation
- Easy accessibility
- Economical transmission

Short Questions

1. State factors affecting site selection.
2. Why is high head desirable?
3. What are characteristics of an ideal site?

GENERAL LAYOUT OF HYDROELECTRIC POWER PLANT

6.1 Layout



Main Components

1. Reservoir

Stores water.

2. Dam

Constructed across river to create reservoir.

3. Intake Structure

Controls water entry into penstock.

4. Penstock

Large pipe carrying water to turbine.

5. Turbine

Converts hydraulic energy into mechanical energy.

Examples:

- Pelton turbine
- Francis turbine
- Kaplan turbine

6. Generator

Converts mechanical energy into electrical energy.

7. Transformer

Increases voltage for transmission.

8. Tailrace

Returns water to river.

Working of Hydroelectric Power Plant

Step 1

Water is stored in reservoir.

Step 2

Water flows through intake and penstock.

Step 3

Water rotates turbine blades.

Step 4

Turbine drives generator.

Step 5

Electricity generated is transmitted to consumers.

Short Questions

1. Draw layout of hydroelectric power plant.
2. What is a penstock?
3. What is tailrace?
4. Explain working of hydroelectric power plant.

CLASSIFICATION OF HYDROELECTRIC POWER PLANTS

7.1 Run-of-River Plant

Definition

Power plant without significant water storage.

Features

- Uses natural river flow.
- Small reservoir.

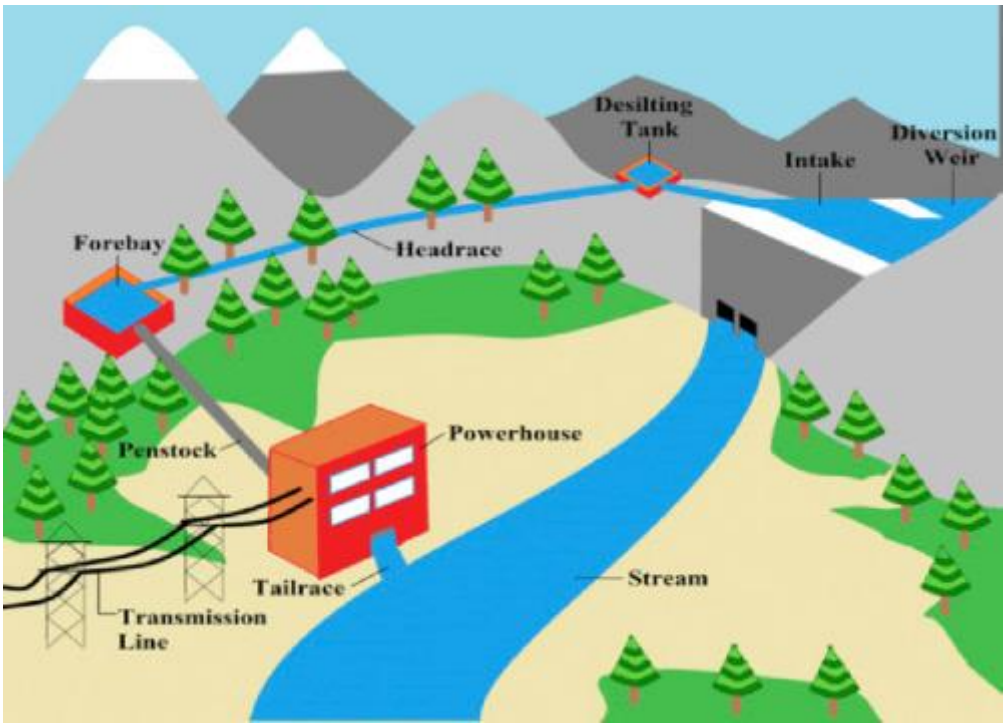
Advantages

- Lower construction cost.

Disadvantages

- Power generation depends on river flow.

Diagram



7.2 Storage Reservoir Plant

Definition

Water is stored in a large reservoir behind a dam.

Features

- Continuous power generation.
- Seasonal flow regulation.

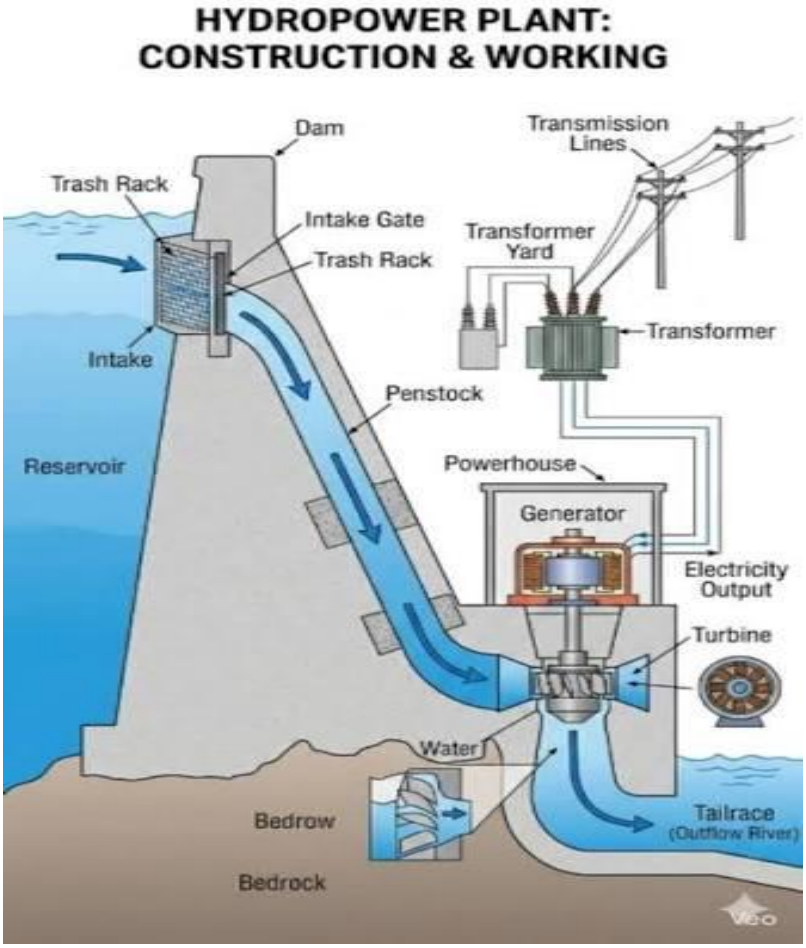
Advantages

- Reliable supply.

Disadvantages

- High initial cost.

Diagram

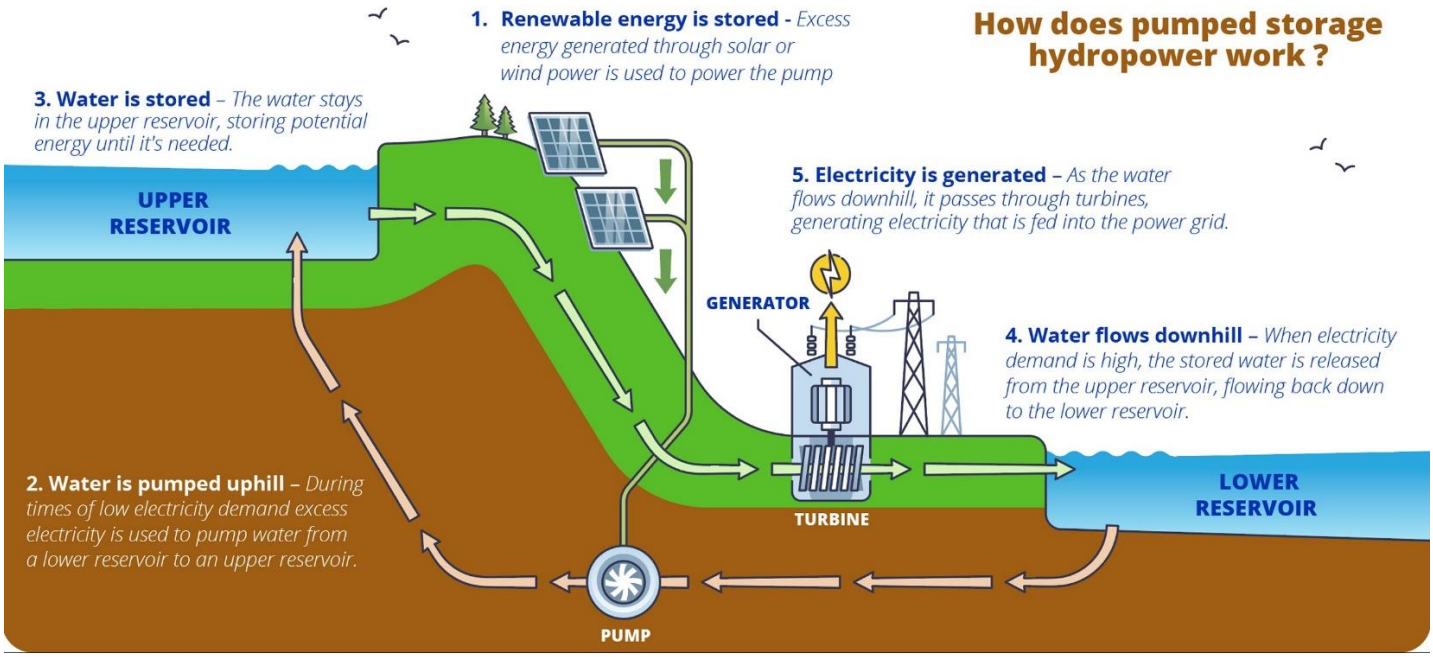


7.3 Pumped Storage Plant

Definition

Water is pumped to upper reservoir during low demand and used during peak demand.

Working



Advantages

- Meets peak load demand.
- Improves grid stability.

Short Questions

1. Classify hydroelectric plants.
2. Explain run-of-river plant.
3. Explain storage plant.
4. Explain pumped storage plant

ADVANTAGES AND DISADVANTAGES OF HYDROELECTRIC POWER PLANT

Advantages

1. Renewable Energy Source

Water is continuously replenished by nature.

2. No Fuel Cost

No requirement of coal, oil or gas.

3. High Efficiency

Efficiency up to 90%.

4. Clean Energy

No air pollution during operation.

5. Long Life

Plant life may exceed 50 years.

6. Low Operating Cost

Maintenance cost is comparatively low.

7. Quick Starting

Can start and stop rapidly.

Disadvantages

1. High Initial Cost

Dam construction requires huge investment.

2. Long Construction Period

Several years required for completion.

3. Dependence on Rainfall

Power generation decreases during drought.

4. Submergence of Land

Large areas may be flooded.

5. Environmental Impact

Affects ecology and wildlife.

6. Relocation Problems

People living near reservoir may require rehabilitation.

COMPARISON OF THERMAL AND HYDRO POWER PLANTS

Parameter	Thermal Plant	Hydro Plant
Fuel Requirement	Required	Not Required
Initial Cost	Lower	Higher
Running Cost	High	Low
Efficiency	30–40%	80–90%
Pollution	High	Negligible
Life Span	25–30 Years	50–100 Years
Starting Time	Long	Very Short

IMPORTANT DIPLOMA EXAMINATION QUESTIONS

Short Questions (2 Marks)

1. Define runoff.
2. What is rainfall?
3. Define hydrograph.
4. What is a flow duration curve?
5. Define penstock.
6. What is tailrace?
7. What is head?
8. State two advantages of hydroelectric plants.

Long Questions (5–10 Marks)

1. Explain the working of a hydroelectric power plant with neat sketch.
2. Discuss rainfall and runoff measurement methods.
3. Explain hydrograph and flow duration curve.
4. Discuss site selection criteria for hydroelectric plants.
5. Classify hydroelectric power plants.
6. Explain run-of-river, storage and pumped storage plants.
7. Discuss advantages and disadvantages of hydroelectric power plants.
8. Compare hydroelectric and thermal power plants.

UNIT–IV: DIESEL POWER PLANT, GAS TURBINE POWER PLANT & NUCLEAR POWER PLANT

INTRODUCTION TO DIESEL POWER PLANT

1.1 Introduction

A diesel power plant uses a diesel engine as the prime mover to drive an alternator for generating electricity.

The chemical energy of diesel fuel is converted into mechanical energy by the engine and then into electrical energy by the generator.

Energy Conversion

Chemical Energy of Diesel
↓
Mechanical Energy (Engine)
↓
Electrical Energy (Generator)

Applications

- Emergency power supply
- Standby power plants
- Small generating stations
- Hospitals
- Industries
- Remote areas

Capacity Range

Generally used for:

- 100 kW to 50 MW

Main Components

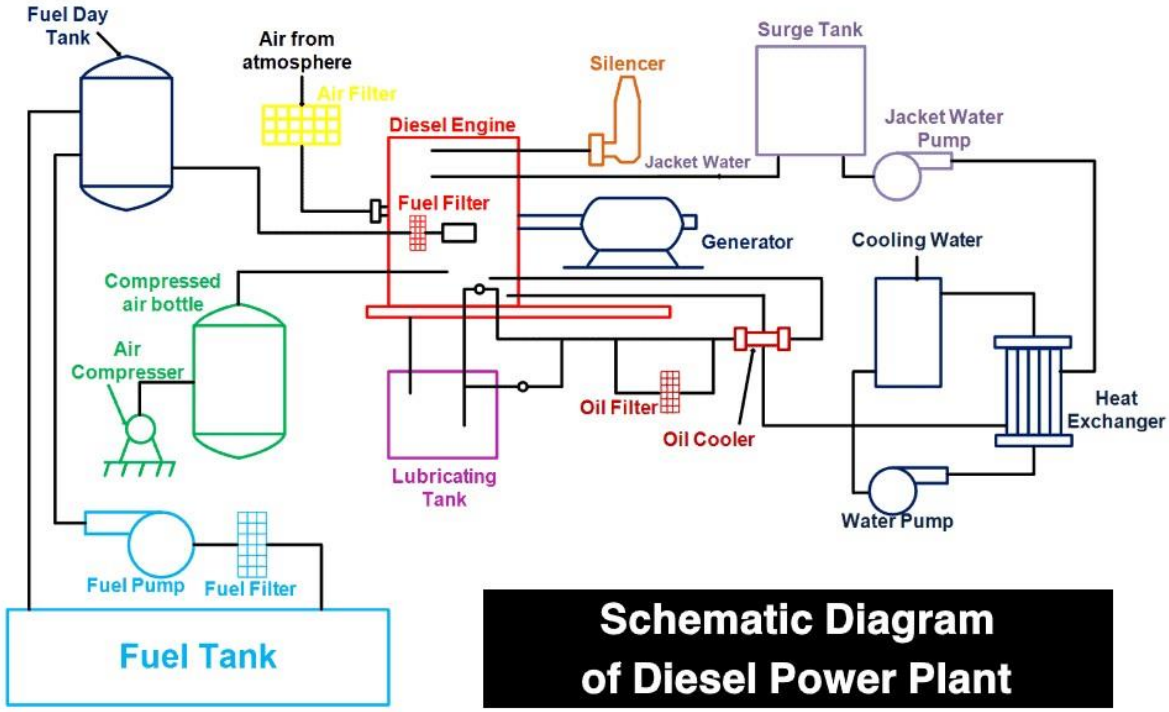
1. Diesel Engine
2. Fuel Supply System
3. Air Intake System
4. Cooling System
5. Lubrication System
6. Starting System
7. Generator

Short Questions

1. Define diesel power plant.
2. What is the prime mover in a diesel power plant?
3. State applications of diesel power plants.

LAYOUT OF DIESEL POWER PLANT

Schematic Layout



Components and Functions

1. Fuel Tank

Stores diesel fuel.

2. Fuel Pump

Supplies fuel at required pressure.

3. Fuel Injector

Injects fuel into combustion chamber.

4. Diesel Engine

Converts fuel energy into mechanical energy.

5. Generator

Converts mechanical energy into electrical energy.

6. Air Filter

Supplies clean air for combustion.

7. Exhaust System

Removes exhaust gases.

8. Cooling System

Maintains safe operating temperature.

9. Lubrication System

Reduces wear and friction.

Short Questions

1. Draw layout of diesel power plant.
2. What is the function of a fuel injector?
3. Why is lubrication necessary?

WORKING OF DIESEL POWER PLANT

Working Principle

Step 1

Air is drawn into the cylinder.

Step 2

Air is compressed to high pressure.

Step 3

Diesel fuel is injected.

Step 4

Fuel ignites automatically due to high temperature.

Step 5

Combustion gases push the piston.

Step 6

Crankshaft rotates the generator.

Step 7

Electricity is generated.

Four Stroke Cycle

Suction Stroke

Air enters cylinder.

Compression Stroke

Air is compressed.

Power Stroke

Fuel burns and produces power.

Exhaust Stroke

Exhaust gases expelled.

Short Questions

1. Explain working of diesel power plant.
2. Name four strokes of diesel engine.

ADVANTAGES AND DISADVANTAGES OF DIESEL POWER PLANT

Advantages

1. Low initial cost.
2. Quick starting.
3. Requires less space.
4. Simple installation.
5. Suitable for standby service.
6. Less cooling water required.

Disadvantages

1. High fuel cost.
2. High maintenance cost.
3. Noise pollution.
4. Limited capacity.
5. Short life compared to hydro plants.

Applications

- Emergency generators
- Mobile power stations
- Hospitals
- Communication centers

INTRODUCTION TO GAS TURBINE POWER PLANT

Definition

A gas turbine power plant uses a gas turbine as the prime mover for electricity generation.

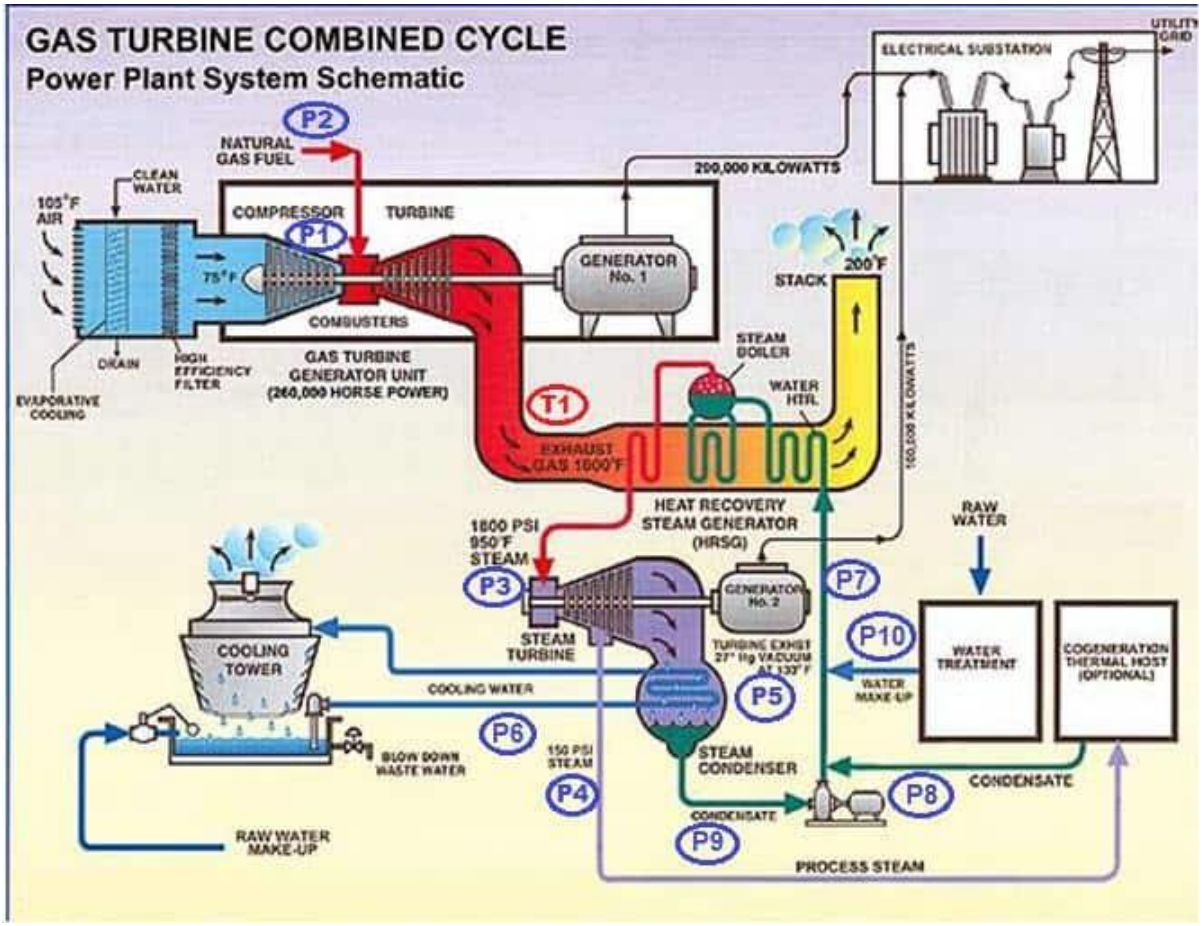
Energy Conversion

Fuel Energy
↓
Thermal Energy
↓
Mechanical Energy
↓
Electrical Energy

Main Components

1. Air Compressor
2. Combustion Chamber
3. Gas Turbine
4. Generator

Schematic Diagram



Short Questions

1. Define gas turbine power plant.
2. Name major components.

WORKING OF GAS TURBINE POWER PLANT

Step 1

Air enters compressor.

Step 2

Compressed air enters combustion chamber.

Step 3

Fuel is injected and burned.

Step 4

High-temperature gases expand through turbine.

Step 5

Turbine rotates generator.

Step 6

Electricity is produced.

Advantages

1. Compact size.
2. Quick starting.
3. Low water requirement.
4. Suitable for peak load.

Disadvantages

1. High fuel consumption.
2. Lower efficiency.
3. High operating temperature.

Short Questions

1. Explain working of gas turbine plant.
2. State advantages of gas turbine plant.

COMBINED CYCLE POWER GENERATION

Introduction

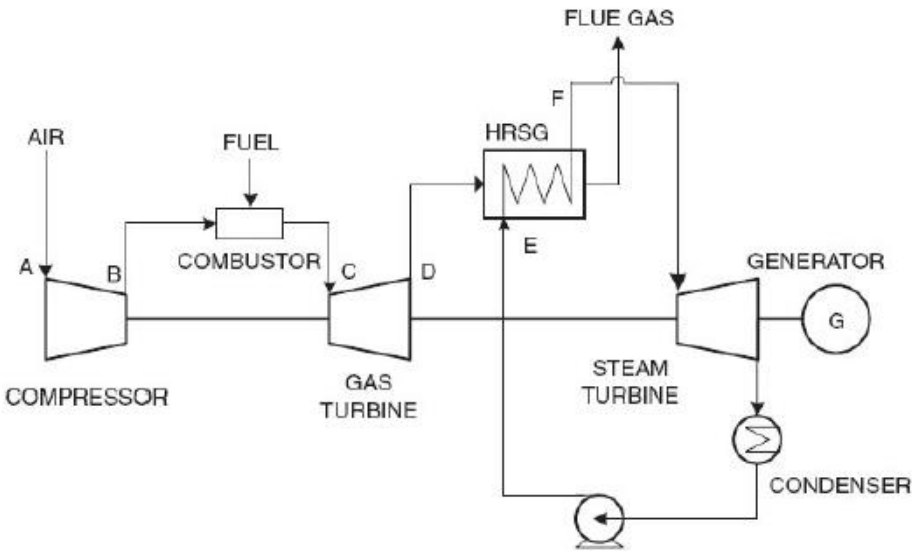
In a combined cycle power plant, both gas turbine and steam turbine are used to improve efficiency.

Principle

Waste heat from gas turbine exhaust is used to generate steam.

The steam drives a steam turbine.

Combined Cycle Flow Diagram



Advantages

1. Higher efficiency (50–60%)
2. Lower fuel consumption
3. Reduced pollution
4. Better utilization of waste heat

Short Questions

1. What is combined cycle generation?
2. Why is combined cycle more efficient?

INTRODUCTION TO NUCLEAR POWER PLANT

Definition

A nuclear power plant generates electricity using heat produced by nuclear fission reactions.

Nuclear Energy

Energy released from the nucleus of an atom.

Common Nuclear Fuels

- Uranium-235
- Plutonium-239
- Uranium-233

Energy Conversion

Nuclear Energy
↓
Thermal Energy
↓
Mechanical Energy
↓
Electrical Energy

Short Questions

1. Define nuclear power plant.
2. Name nuclear fuels.

RADIOACTIVITY AND NUCLEAR REACTIONS

Radioactivity

Spontaneous emission of radiation from unstable atomic nuclei.

Types of Radiation

Alpha (α) Rays

- Positively charged
- Low penetration

Beta (β) Rays

- Negatively charged
- Moderate penetration

Gamma (γ) Rays

- Electromagnetic radiation
- Very high penetration

Nuclear Reactions

Fission Reaction

Heavy nucleus splits into smaller nuclei.

Example:

U-235 + Neutron
↓
Fission Products + Energy

Fusion Reaction

Light nuclei combine.

Example:

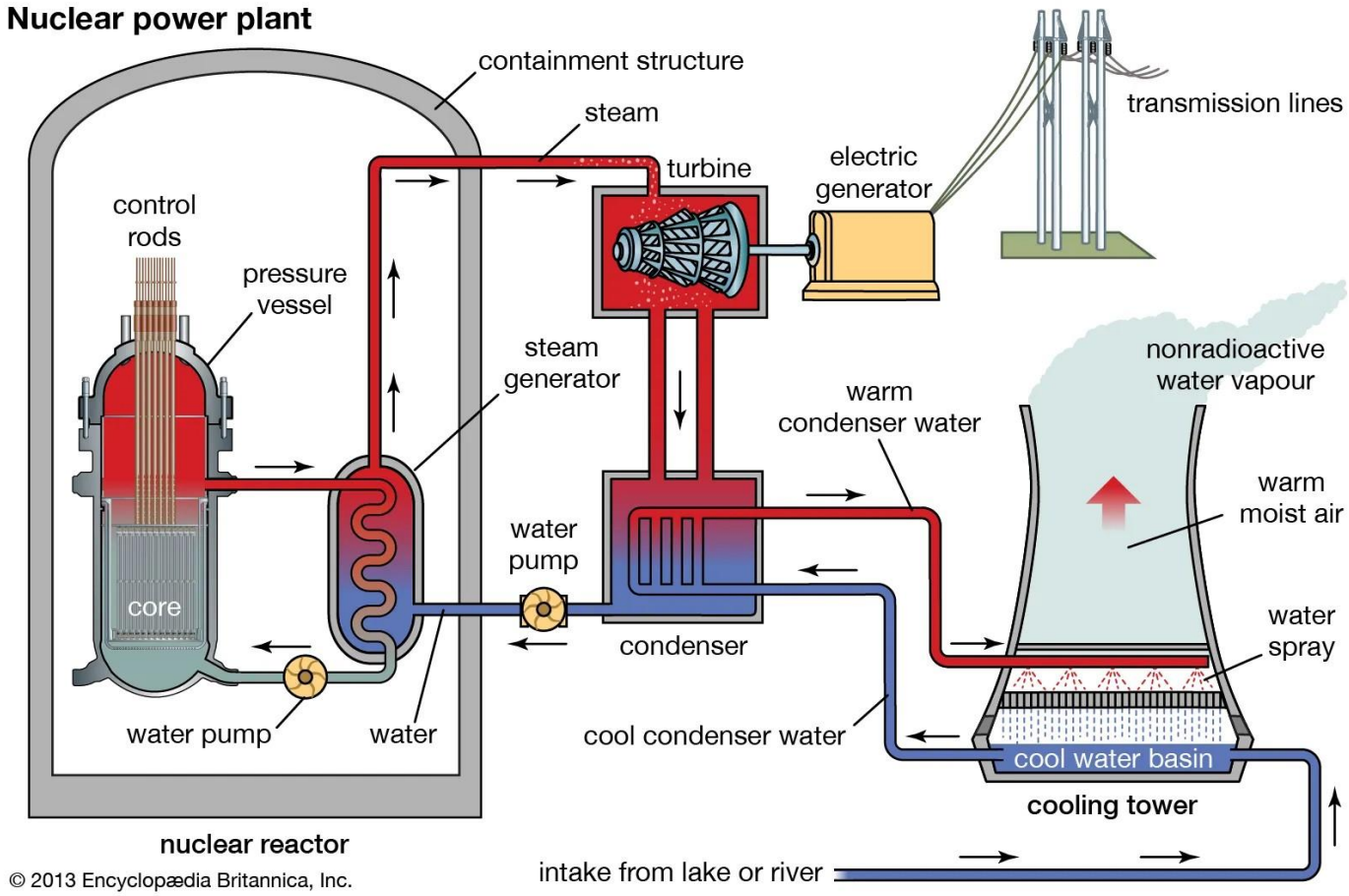
Hydrogen → Helium

Short Questions

1. Define radioactivity.
2. What are alpha rays?
3. Define nuclear fission.

WORKING OF NUCLEAR POWER PLANT

Schematic Layout



SCHEMMATIC DIAGRAM OF A NUCLEAR REACTOR

Main Components

Reactor

Site of nuclear fission.

Moderator

Slows down neutrons.

Examples:

- Graphite
- Heavy Water

Control Rods

Control chain reaction.

Materials:

- Cadmium
- Boron

Coolant

Removes heat.

Examples:

- Water
- Carbon dioxide
- Liquid sodium

Steam Generator

Produces steam.

Turbine and Generator

Generate electricity.

Working

Nuclear reactors generate electricity by harnessing **nuclear fission**. Atoms of heavy elements, typically Uranium-235, are split by neutrons. This controlled chain reaction releases immense thermal energy, which converts water to high-pressure steam. The steam drives a turbine, spinning a generator to produce electrical power.

4 Main Stages of the Process

1. Heat Generation (The Reactor Core)

- **Fission:** Inside the reactor vessel, Uranium fuel rods undergo a controlled chain reaction. Fission occurs when a neutron hits a uranium atom, splitting it and releasing more neutrons and a massive amount of heat.
- **Control:** Specialized materials (like silver or boron) are built into **control rods**. These are inserted to absorb neutrons and slow the reaction, or withdrawn to increase it, keeping the heat perfectly stable.
- **Moderation:** A moderator (like graphite or normal water) slows down fast-moving neutrons so they can successfully trigger subsequent fissions.

2. Heat Transfer (The Coolant)

- Coolant—usually water—is pumped through the reactor core to absorb the heat generated by the fission process.
- In a **Pressurized Water Reactor (PWR)**, the water in the core is kept under extreme pressure so it gets incredibly hot but does not boil. This super-heated, radioactive water is then pumped into a heat exchanger or steam generator.

3. Steam Creation (The Secondary Loop)

- Inside the steam generator, the hot, radioactive core water flows through pipes to heat a separate, unpressurized loop of clean water.
- This clean water absorbs the heat and flashes into highly pressurized steam.

4. Electricity Production (Turbine & Generator)

- The high-pressure steam is directed into massive blades of a **steam turbine**. The forceful steam pressure spins the turbine blades at incredibly high speeds, converting thermal energy into mechanical energy.

- The spinning turbine is connected to a **generator**, which transforms the mechanical motion into electrical energy via magnetic fields.
- The electricity is then sent to a transformer to step up the voltage for long-distance transmission across the power grid.
- After turning the turbine, the steam is cooled back into liquid water in a condenser and recycled back into the steam generator.

Short Questions

1. Draw layout of nuclear power plant.
2. What is moderator?
3. What is coolant?

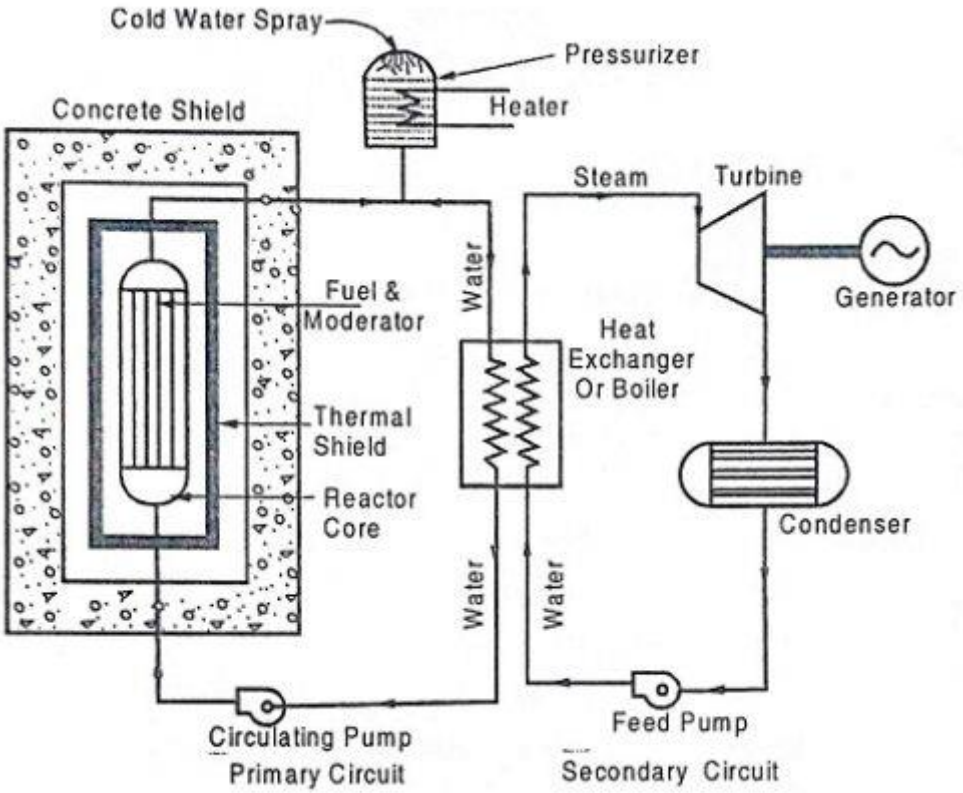
THERMAL FISSION REACTORS

1. Pressurized Water Reactor (PWR)

Principle

Water under high pressure acts as coolant and moderator.

Layout of Pressurized Water Reactor (PWR)



Working:

A **Pressurized Water Reactor (PWR)** generates electricity using nuclear fission to heat water in a sealed primary loop. This high-pressure, super-heated water transfers its thermal energy to a secondary, lower-pressure loop in a steam generator, which flashes to steam, spins a turbine, and powers an electric generator.

The 3 Main Circuits

A PWR operates through three distinct, closed loops to ensure safety and continuous operation:

1. **The Primary Loop:**
    - Uses ordinary water as both a **coolant** and a **neutron moderator** (to slow down fast neutrons and sustain the nuclear chain reaction).
    - Kept under extreme pressure (around 150-160 atm), ensuring the water remains in a liquid state even when heated up to 325°C.
    - A **pressurizer** with electrical heaters and water sprays actively maintains this exact pressure to prevent boiling or dangerous pressure spikes.
2. **The Secondary Loop:**
    - Water in this loop flows through tubes inside the **steam generator**.
    - Because the secondary loop is at a much lower pressure, the heat from the primary loop causes the secondary water to instantly vaporize into high-pressure steam.
    - *Safety benefit:* The water in the primary and secondary loops never mixes, keeping radioactive material safely contained in the reactor vessel.
3. **The Tertiary (Cooling) Loop:**
    - The high-pressure steam from the secondary loop drives a massive **steam turbine**.
    - Once the steam passes through the turbine, it is routed to a **condenser**.
    - Cold water pumped from a nearby source (e.g., the ocean or a cooling tower) cools the steam, converting it back into liquid water so it can be pumped back into the steam generator

Advantages

- Safe operation
- Widely used

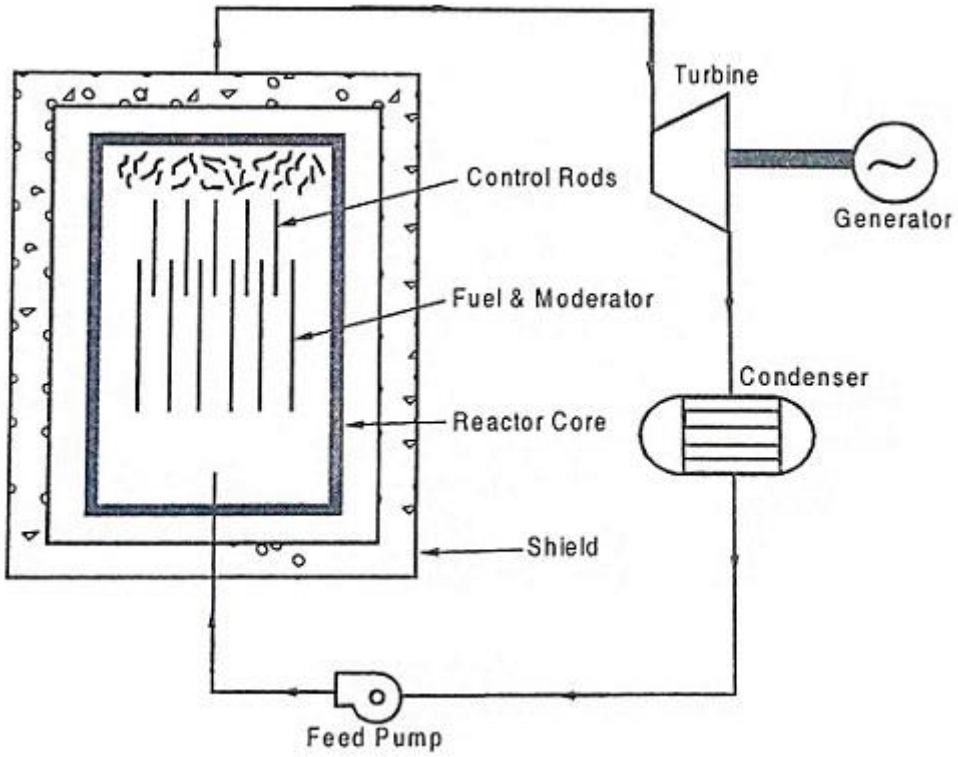
2. Boiling Water Reactor (BWR)

Principle

Water boils directly in reactor.

Steam generated drives turbine.

Layout of Boiling Water Reactor (BWR)



Working:

A Boiling Water Reactor (BWR) uses heat from nuclear fission to boil water directly into steam. This steam drives a turbine, which spins a generator to produce electricity. It functions in a single continuous loop where the reactor core acts as both the heat source and steam generator.

Key Components

- **Reactor Core:** Contains fuel rods filled with enriched uranium, where nuclear fission takes place to generate massive amounts of heat.
- **Control Rods:** Made of neutron-absorbing materials (like boron). They are inserted or withdrawn to control the rate of fission and regulate power output.
- **Water:** Acts as both a coolant (to carry heat away) and a moderator (to slow down neutrons and sustain the chain reaction).
- **Steam Separators and Dryers:** Internal devices at the top of the reactor vessel that remove moisture from the steam before it exits.

- **Turbine and Generator:** The equipment that converts the thermal and mechanical energy of the steam into electrical energy.
- **Condenser:** Cools the exhaust steam back into liquid water (condensate) to be pumped back into the reactor.

Step-by-Step Working Principle

1. Heat Generation

Water is pumped into the reactor pressure vessel and flows upwards through the fuel assemblies in the core. The nuclear fission of uranium generates intense heat, causing the water to boil and turn into a mixture of water and steam.

2. Steam Separation and Drying

As the boiling mixture rises, it enters moisture separators and steam dryers. These components strip the water droplets from the steam, ensuring that only dry, high-quality steam travels out of the reactor pressure vessel.

3. Power Generation

The dry steam is directed through high-pressure and low-pressure pipes to drive a turbine. As the steam pushes against the turbine blades, it causes the turbine to spin at high speeds. This rotational mechanical energy powers an electrical generator to produce electricity.

4. Condensation and Feedwater Loop

After passing through the turbine, the steam enters a condenser where it is cooled by circulating cold water and turns back into liquid water (condensate). This liquid is then treated, preheated, and pumped back into the reactor as feedwater to repeat the cycle.

Advantages

- Simple design
- Lower cost

3. Gas Cooled Reactor

Principle

Carbon dioxide or helium used as coolant.

Graphite used as moderator.

Advantages

- High operating temperature
- Better efficiency

Short Questions

1. What is PWR?
2. What is BWR?
3. What is gas cooled reactor?

ADVANTAGES AND DISADVANTAGES OF NUCLEAR POWER PLANT

Advantages

1. Very high energy density.
2. Small fuel requirement.
3. Low fuel transportation cost.
4. Low air pollution.
5. Suitable for base load operation.
6. Requires less land.

Disadvantages

1. Very high initial cost.
2. Radioactive waste disposal problem.
3. Radiation hazards.
4. Complex maintenance.
5. Long construction period.

COMPARISON OF THERMAL, DIESEL AND NUCLEAR PLANTS

Parameter	Thermal	Diesel	Nuclear
Initial Cost	Medium	Low	Very High
Fuel Cost	High	Very High	Low
Efficiency	Moderate	High	High
Pollution	High	High	Low
Capacity	Large	Small	Very Large
Starting Time	Moderate	Very Fast	Slow

IMPORTANT DIPLOMA EXAMINATION QUESTIONS

Short Questions (2 Marks)

1. Define diesel power plant.
2. What is a fuel injector?
3. Define gas turbine plant.
4. What is combined cycle generation?
5. Define radioactivity.
6. What is nuclear fission?
7. What is a moderator?
8. What is a control rod?
9. Define PWR.
10. Define BWR.

Long Questions (5–10 Marks)

1. Draw and explain the layout of a diesel power plant.
2. Explain working of a diesel power plant.
3. Discuss advantages and disadvantages of diesel power plants.
4. Explain schematic diagram and operation of gas turbine power plant.
5. Explain combined cycle power generation with flow diagram.
6. Explain radioactivity and nuclear fission.
7. Draw and explain the layout of a nuclear power plant.
8. Explain working of a nuclear power plant.
9. Describe PWR, BWR and gas-cooled reactors.
10. Discuss advantages and disadvantages of nuclear power plants.

UNIT–V : ENVIRONMENTAL IMPACT OF POWER PLANTS AND POWER PLANT SAFETY

ENVIRONMENTAL IMPACT OF POWER PLANTS

SOCIAL AND ECONOMIC ISSUES OF POWER PLANTS

1.1 Introduction

Power plants contribute significantly to industrial growth and economic development. However, they also create several social and economic issues that must be addressed.

1.2 Social Issues

1. Displacement of Population

Large power projects often require acquisition of large areas of land leading to displacement of local communities.

Examples:

- Hydroelectric projects requiring large reservoirs.
- Thermal power plants requiring ash disposal areas.

2. Rehabilitation and Resettlement

Displaced people require:

- Housing facilities
- Employment opportunities
- Educational facilities
- Healthcare facilities

3. Health Impacts

Air pollutants emitted from thermal power plants may cause:

- Asthma
- Bronchitis
- Respiratory diseases

4. Environmental Degradation

Power plants may affect:

- Forests
- Agricultural land
- Wildlife habitats

1.3 Economic Issues

Positive Economic Effects

- Employment generation
- Industrial development
- Regional infrastructure development
- Increased government revenue

Negative Economic Effects

- High capital investment
- Rehabilitation costs
- Environmental protection expenses
- Maintenance and waste disposal costs

Short Questions

1. State social issues associated with power plants.
2. Mention economic benefits of power plants.
3. Why is rehabilitation necessary?

GREENHOUSE EFFECT

2.1 Definition

The greenhouse effect is the warming of the Earth's atmosphere caused by the trapping of heat by greenhouse gases.

2.2 Greenhouse Gases

Major greenhouse gases include:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Water vapour
- Chlorofluorocarbons (CFCs)

2.3 Mechanism of Greenhouse Effect

Sunlight enters atmosphere

↓

Earth absorbs heat

↓

Earth radiates heat back

↓

Greenhouse gases trap heat

↓

Rise in atmospheric temperature

2.4 Causes

- Burning of fossil fuels
- Deforestation
- Industrial emissions
- Transportation emissions

2.5 Effects

- Global warming
- Melting of glaciers
- Sea level rise
- Climate change
- Extreme weather conditions

2.6 Control Measures

- Renewable energy utilization
- Afforestation
- Energy conservation
- Reduction of fossil fuel consumption

Short Questions

1. Define greenhouse effect.
2. Name greenhouse gases.
3. State effects of global warming.

ACID PRECIPITATION

3.1 Definition

Acid precipitation refers to the deposition of acidic substances from the atmosphere onto the earth's surface.

It is mainly caused by:

- Sulphur dioxide (SO_2)
- Nitrogen oxides (NOx)

Formation of Acid Rain

$$SO_2 + H_2O \rightarrow H_2SO_4 \text{ (Sulphuric Acid)}$$

$$NOx + H_2O \rightarrow HNO_3 \text{ (Nitric Acid)}$$

3.2 Types of Acid Precipitation

1. Acid Rain

Acidic rainwater falling from clouds.

2. Acid Snow

Acidic substances deposited through snowfall.

3. Dry Deposition

Acidic gases and particles settle directly on surfaces without precipitation.

4. Acid Fog

Acidic water droplets suspended in air.

3.3 Effects

- Damage to buildings and monuments.
- Soil degradation.
- Damage to crops.
- Harm to aquatic life.
- Corrosion of metals.

3.4 Prevention

- Use of low sulphur fuels.
- Flue gas desulphurization.
- Installation of scrubbers.
- Use of cleaner energy sources.

Short Questions

1. Define acid precipitation.
2. What causes acid rain?
3. What is dry deposition?

POLLUTION FROM POWER PLANTS

4.1 Air Pollution

Major Pollutants

- Carbon dioxide (CO_2)
- Sulphur dioxide (SO_2)
- Nitrogen oxides (NOx)
- Fly ash
- Carbon monoxide (CO)

Effects

- Respiratory diseases
- Global warming
- Acid rain
- Reduced visibility

Control Measures

- Electrostatic precipitators
- Cyclone separators
- Bag filters
- Chimneys

4.2 Water Pollution

Sources:

- Boiler blowdown water
- Cooling water discharge
- Chemical waste
- Oil leakage

Effects

- Reduced dissolved oxygen
- Harm to aquatic life
- Water contamination

Control Measures

- Wastewater treatment plants
- Recycling and reuse of water
- Oil separators

4.3 Thermal Pollution

Definition

Discharge of heated water into rivers or lakes causing temperature rise.

Effects

- Reduced oxygen content
- Disturbance of aquatic ecosystem
- Fish mortality

Control Measures

- Cooling towers
- Cooling ponds
- Heat exchangers

Short Questions

1. Name major air pollutants from thermal plants.
2. Define thermal pollution.
3. Mention methods of controlling air pollution.

RADIATION FROM NUCLEAR POWER PLANT EFFLUENTS

5.1 Introduction

Nuclear power plants produce radioactive waste during operation.

Sources of Radiation

- Reactor coolant
- Spent fuel
- Radioactive gases
- Liquid effluents

Types of Radiation

Alpha Radiation

Low penetration.

Beta Radiation

Moderate penetration.

Gamma Radiation

Very high penetration.

Effects on Human Health

- Skin burns
- Cancer
- Genetic mutations
- Radiation sickness

Protection Methods

Shielding

Use of:

- Lead
- Concrete
- Water

Containment Structures

Prevent leakage of radioactive materials.

Monitoring Systems

Continuous radiation monitoring.

Waste Disposal Methods

- Deep geological disposal
- Vitrification
- Shielded storage containers

Short Questions

1. Name radioactive emissions from nuclear plants.
2. What is shielding?
3. Which radiation has highest penetration?

ENVIRONMENTAL PROTECTION MEASURES

Methods to Reduce Environmental Impact

Thermal Plants

- Use of supercritical boilers.
- Installation of ESP.
- Carbon capture technologies.

Hydro Plants

- Fish ladders.
- Controlled reservoir management.

Nuclear Plants

- Proper waste management.
- Radiation shielding.

Renewable Plants

- Increased use of solar and wind energy.

Sustainable Development

Meeting present energy needs without compromising future generations.

POWER PLANT SAFETY CONCEPT

7.1 Definition

Power plant safety refers to the prevention of accidents, injuries, and damage to equipment during operation and maintenance activities.

Objectives of Safety

- Protection of workers.
- Protection of equipment.
- Protection of environment.
- Continuous operation.

Safety Triangle

Safety
/ \
People Equipment
\ /
Environment

Causes of Accidents

- Human error
- Equipment failure
- Poor maintenance
- Unsafe working practices

Short Questions

1. Define plant safety.
2. State objectives of safety.

SAFETY POLICY IN POWER PLANTS

Important Safety Policies

1. Use Personal Protective Equipment (PPE)

Examples:

- Helmet
- Gloves
- Safety shoes
- Goggles
- Ear protection

2. Permit to Work System

Work must start only after proper authorization.

3. Lockout and Tagout (LOTO)

Prevents accidental energization of equipment.

4. Fire Protection System

Includes:

- Fire extinguishers
- Fire alarms
- Sprinklers

5. Safety Training

Regular training for employees.

Short Questions

1. What is PPE?
2. Explain LOTO.
3. Why is safety training necessary?

SAFETY IN BOILER OPERATION

Boiler Hazards

- Explosion
- Fire
- Steam leakage
- Tube failure

Safety Practices

1. Regular Inspection

Check:

- Pressure gauge
- Safety valve
- Water level indicator

2. Maintain Correct Water Level

Low water level may cause overheating.

3. Test Safety Valves

Ensure proper operation.

4. Use Treated Feed Water

Prevents scaling and corrosion.

5. Follow Operating Procedures

Strict adherence to SOPs.

Important Boiler Safety Devices

- Safety valve
- Pressure gauge
- Water level indicator
- Fusible plug

Short Questions

1. Name boiler safety devices.
2. Why is water level important?

SAFETY IN OIL HANDLING AND CHEMICAL HANDLING

Safety in Oil Handling

Hazards

- Fire
- Explosion
- Leakage

Safety Measures

- Proper storage tanks.
- Earthing and bonding.
- No smoking zones.
- Fire extinguishers nearby.
- Leak detection systems.

Safety in Chemical Handling

Chemicals Used

- Acids
- Alkalis
- Water treatment chemicals

Safety Practices

- Use protective gloves.
- Wear goggles and face shields.
- Proper labelling of containers.
- Emergency showers and eye wash stations.
- Adequate ventilation.

Short Questions

1. Mention hazards in oil handling.
2. State safety measures in chemical handling.

STATUTORY PROVISIONS RELATED TO BOILER OPERATION

11.1 Introduction

Boilers operate under high pressure and temperature. Therefore, legal provisions are essential to ensure safety.

Important Provisions

1. Boiler Registration

Every boiler must be registered with the appropriate authority.

2. Inspection and Certification

Periodic inspection is mandatory.

3. Qualified Boiler Operators

Only certified operators should operate boilers.

4. Safety Valve Testing

Mandatory testing and calibration.

5. Maintenance Records

Detailed maintenance records should be maintained.

Important Legislation in India

- The Indian Boilers Act, 1923
- Indian Boiler Regulations (IBR)

Objectives of Boiler Regulations

- Prevent accidents.
- Ensure safe operation.
- Standardize boiler design and inspection.

Short Questions

1. What is IBR?
2. Why is boiler registration necessary?
3. Name the important boiler legislation in India.

IMPORTANT DIPLOMA EXAMINATION QUESTIONS

Short Questions (2 Marks)

1. Define greenhouse effect.
2. What is acid rain?
3. Define thermal pollution.
4. What is dry deposition?
5. What is radiation shielding?
6. Define plant safety.
7. What is PPE?
8. Define LOTO.
9. What is IBR?
10. Name boiler safety devices.

Long Questions (5–10 Marks)

1. Discuss social and economic issues associated with power plants.
2. Explain greenhouse effect and global warming.
3. Explain acid precipitation and its different forms.
4. Discuss air, water and thermal pollution from power plants.
5. Explain radiation hazards from nuclear power plants.
6. Discuss safety policies in power plants.
7. Explain safety practices in boiler operation.
8. Discuss safety in oil handling and chemical handling systems.
9. Explain statutory provisions related to boiler operation in India.
10. Discuss environmental impacts of various power plants and their mitigation measures.

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