NEPAL ENGINEERING COUNCIL

LICENSE EXAMINATION PREPARATION COURSE
FOR
CIVIL ENGINEERS
on
Hydropower Engineering

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8. Hydropower **(ACiE08)**

8.1 Planning of hydropower projects: power potential (gross, technical, economic) of Nepal and the world; stages of hydropower development, hydropower development in Nepal (history, policy, acts & regulation.) (ACiE0801)

8.2 Power and energy potential study: power and energy potentials; methods of fixing installed capacity of a plant; types of hydropower plants on various basis; components of different types of hydropower projects; reservoirs and their regulation. (ACiE0802)

8.3 Headworks of storage plants: components of a typical storage plant; dams (types, functions, selection, design, failure modes and remedies); stability analysis of gravity dam, seepage control and foundation treatment in dams; design of intake, spillway and energy dissipaters; gates (types and locations). (ACiE0803)

8.4 Headworks of run-of-river (ROR) plants: components of a typical ROR plant; design of intake; methods of bed and suspended load handling; design of settling basin (practice and concentration approach), estimation of sediment volume in settling basin, flushing of deposited sediment, estimation of flushing frequency for sediments. (ACiE0804)

8.5 Water conveyance structures: hydraulic tunnels, x-sections, and hydraulic design (velocity and sizing); tunnel lining; design of forebay and surge tanks; design of penstocks and pressure shaft; hydraulic transients (water hammer). (ACiE0805)

8.6 Hydro-electric machines and powerhouse: hydro-mechanical equipment and their functions; types of turbines and performance characteristics; selection of turbine and their specific speed; preliminary design of Francis and Pelton turbines; scroll case and draft tubes; generators (types, rating); governs; pumps and their performance characteristics; powerhouse (types, general arrangements, dimensions). (ACiE0806)

8.2 Power and Energy Potential Study

8.2.1 Power and energy potentials

8.2.2 Methods of fixing installed capacity of plants

8.2.3 Types of hydropower plants on various basis

8.2.4 Components of different types of hydropower projects

8.2.5 Reservoir and their regulation

8.2 Power and Energy Potential Study

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Hydropower study data requirements:

1. Hydrological data.

   Avg. Precipitation:

   - Thiessen polygon method
   - Isohyets method
   - Simple arithmetic mean method.

   Run off/discharge:

   - Hydrograph, flow duration curve, mass curve.
   - Infiltration (ϕ – index, w – index), evaporation.

8.2 Power and Energy Potential Study

2. Geological Data: Fault, fold, rock strata, joint.
3. Topography (catchment area, contour)
4. Socio-economic data area
5. Power Market Data
6. Sediment data

8.2.1 Power and energy potentials

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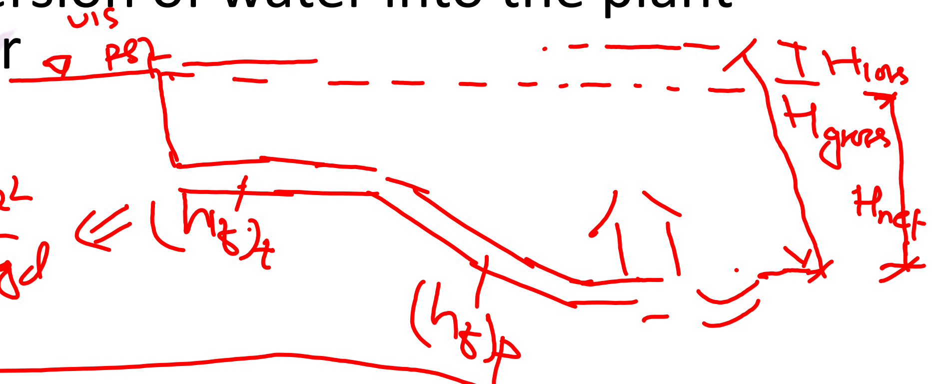
Gross Head:

- a difference of water level in the headrace and tailrace
- for storage plant, difference between water level in reservoir and tailrace
- for ROR, level difference between point of diversion of water into the plant and point where water is returned back to river



$P = \eta \gamma Q H_{net}$

$\frac{fLV^2}{2gd} \Leftarrow (h_f)_t$

$(h_f)_p$

Net Head (Effective Head)

- actual head available for the plant
- for impulse turbine, Net head= Gross head – sum of all head losses
- for reaction turbine, Net head= Gross head- sum of all head loss + Suction pressure head

$H_G \quad (H_L) \quad + H_{suction}$

Pelton

Francis, Kaplan

8.2.1 Power and energy potentials

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Flow Duration Curve: (FDC)

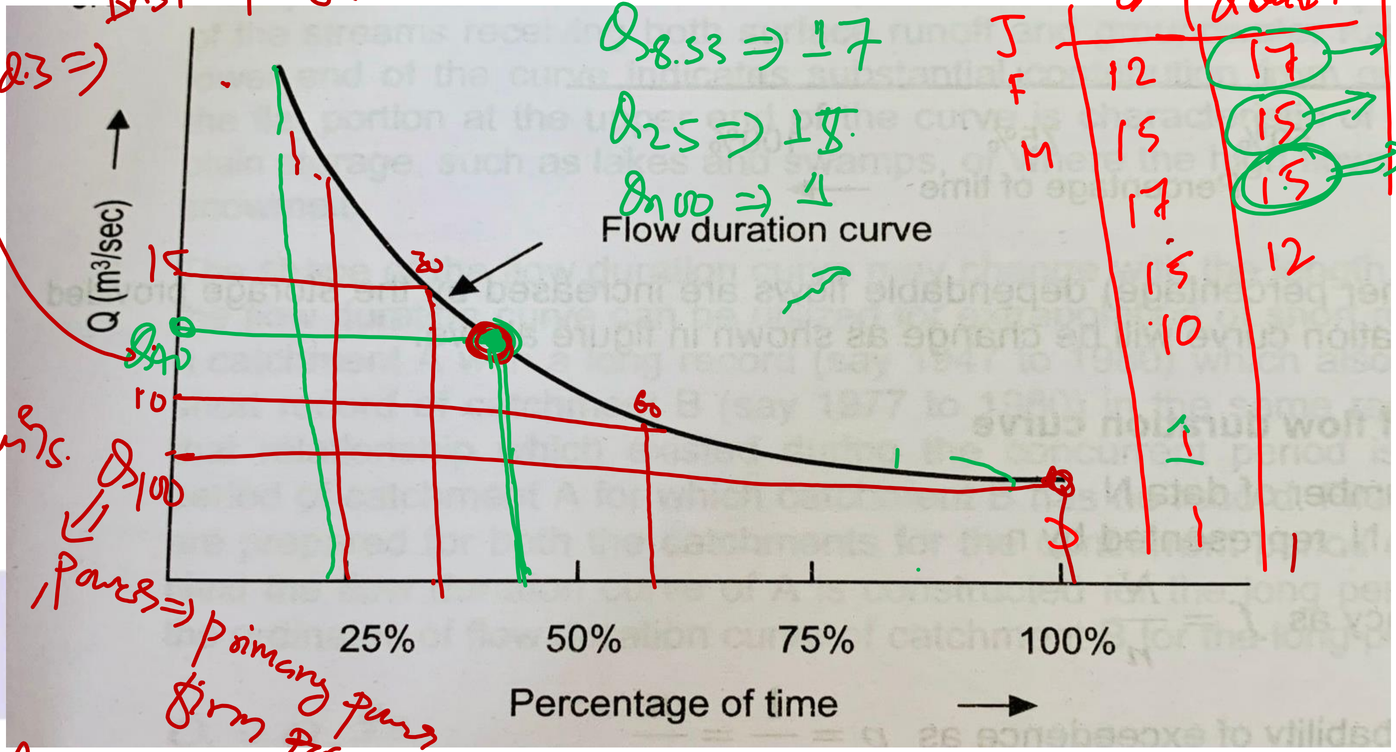
- Graphical representation between discharge in y-axis and % of time in x-axis.

$P = \gamma Q H \eta$

- What is Q40?
- Q30 is less or greater than Q60?

Use:

- Planning and design Of HPP



Inst. capacity (20MW)

Inst. cap = Max^m power production capacity of HPP

Primary power / Firm power

8.2.1 Power and energy potentials

Based on the availability of discharge:

Firm power:

The net power continuously available from a plant to consumer at any time is called firm power. It is also called Primary power. It is available 100% of the time. It corresponds to minimum stream flow. Firm power can be increased by pondage.

Secondary Power:

The excess power available over firm power is called secondary power. It is also called surplus or non-firm power. It is available only in periods of high flow in river.

8.2.1 Power and energy potentials

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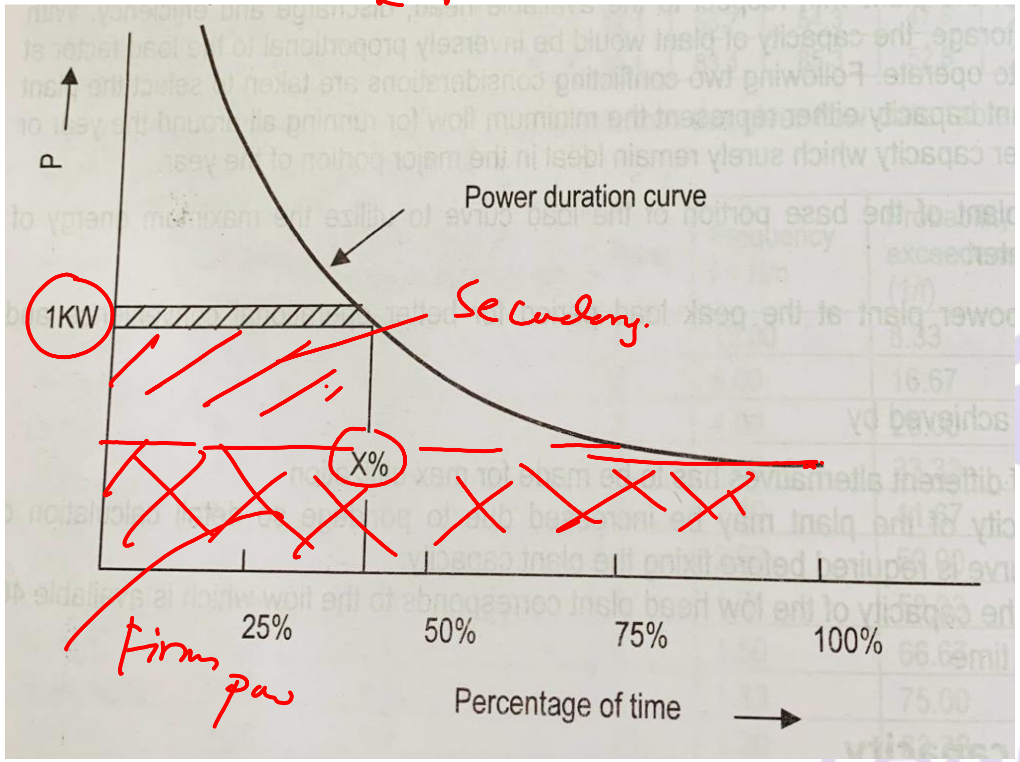
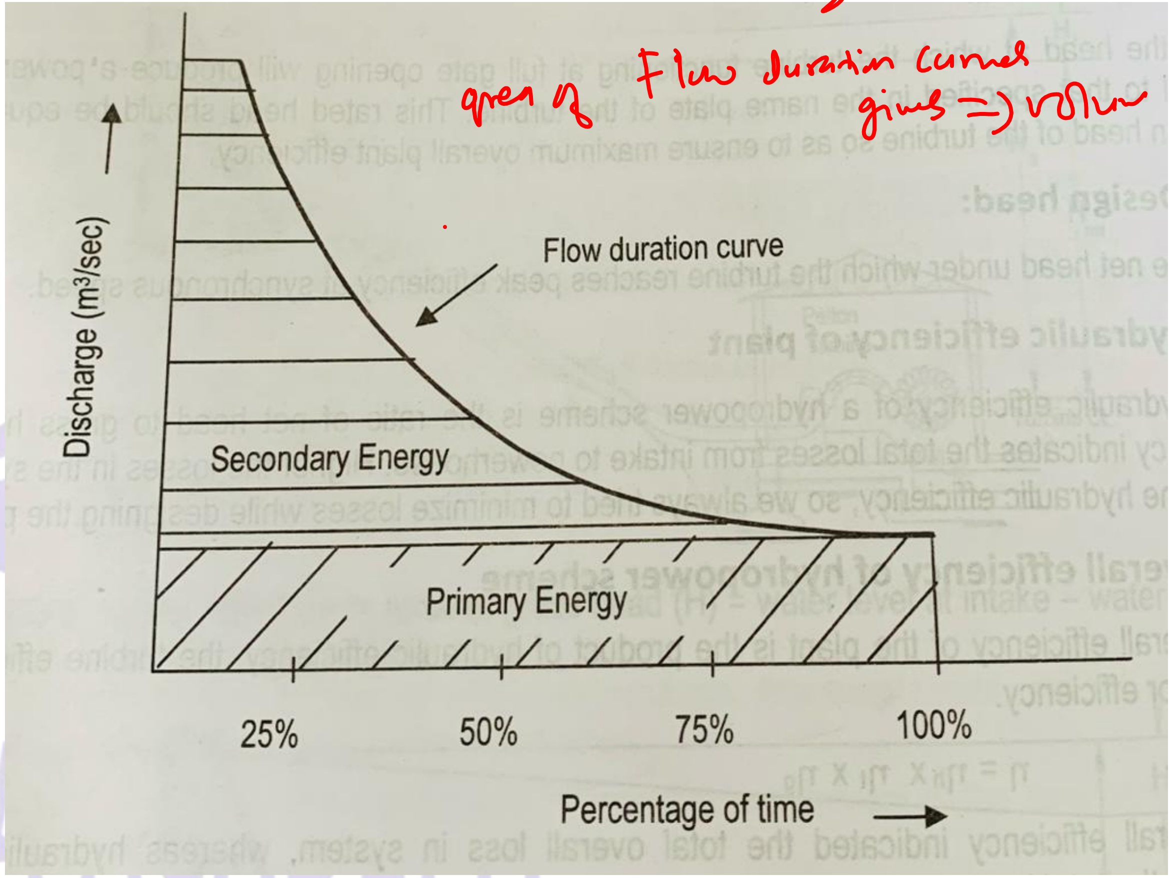
m³/s.* time.
⇒ volume

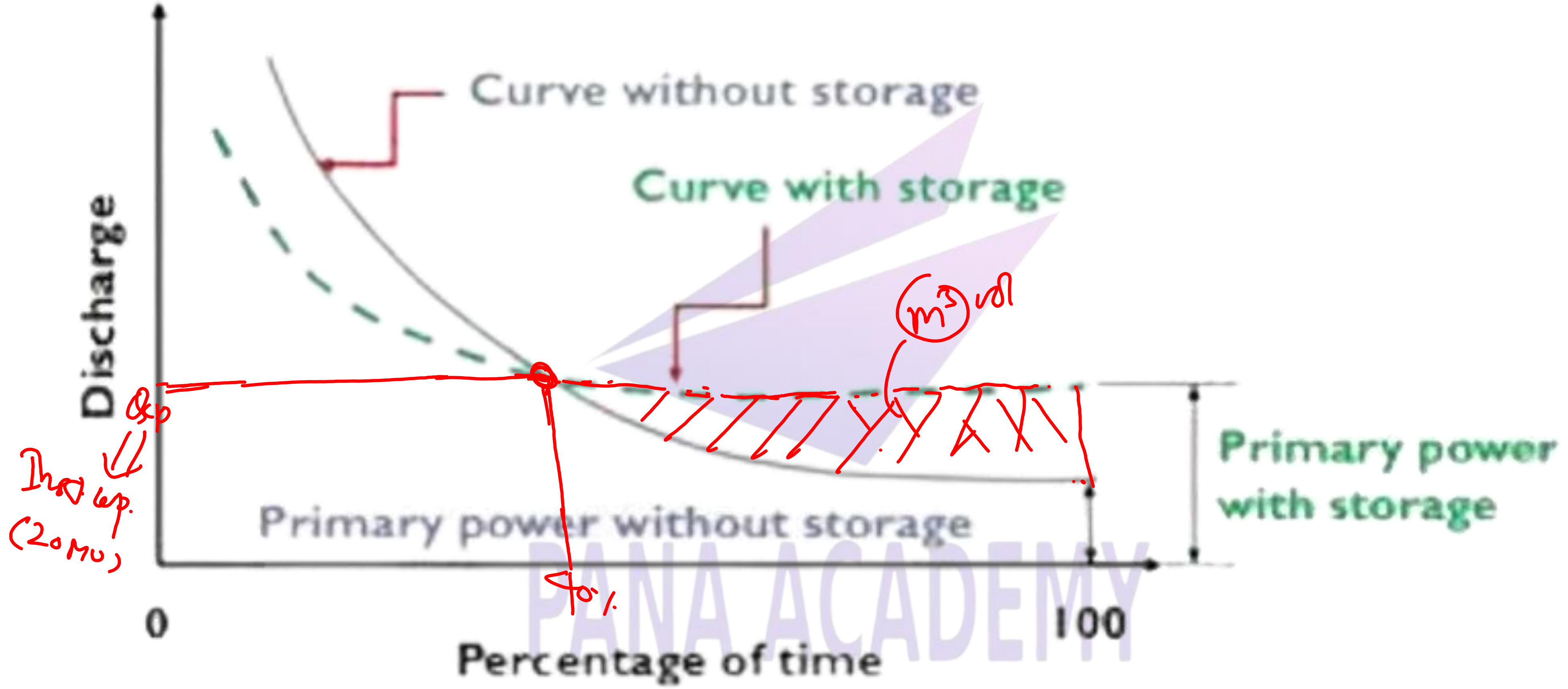
PDC Area ⇒ Energy
kW*hr (kWhr)



area of Flow duration curve
gives ⇒ volume



8.2.1 Power and energy potentials



8.2.1 Power and energy potentials

$Q_{100} = 5\ m^3/s.$

Firm Energy = ?

Firm power = ?

$h = 10m$

$\eta = 0.8$

Classification of energy

Based on the availability of discharge:

Firm energy:

Maximum continuous energy available for a plant under the most adverse hydraulic conditions. Energy corresponding to firm power is called firm energy.

$\text{Power } (P) = \eta \gamma Q H$

$\text{Energy } (E) = \text{Power} \times \text{time}.$

$\text{Firm power} = \eta \gamma \cancel{QH}$

$= 0.8 \times 9.81 \times 5 \times 10$

$= 392\ kW$

$\text{Firm Energy} = 392 \times 365 \times 24\ (kWhr)$

Secondary energy

The area of power duration curve gives energy. Its unit is watt.sec or KWh or GWh.

Secondary power= Design Power- Firm Power

Secondary Energy= Total Energy – Firm Energy

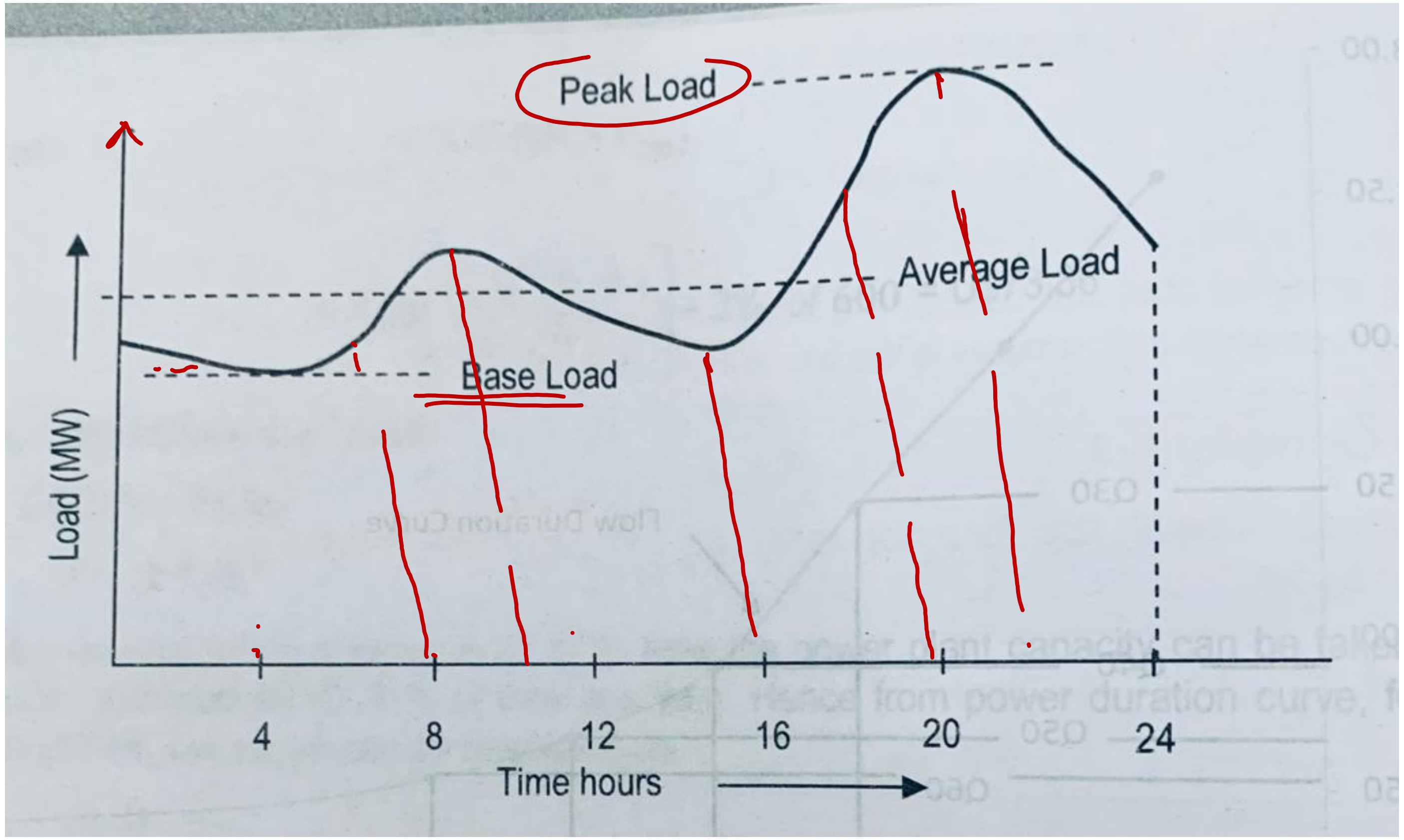
8.2.1 Power and energy potentials

Power Demand is also called **Load demand**. Different types of load are:

1. Average load

2. Peak Load

3. Base Load



Load Curve

8.2.1 Power and energy potentials

Some Basic Formula to keep in mind

- Load Factor= Average Load / Peak Load (≤1) (LAP)
  (LF)
  $L.F = \frac{Avg}{peak}$
- Plant or Capacity Factor= Average Load/ Plant capacity (0.25-0.7)
  (CF) Capacity Factor = $\frac{Avg}{Inst.}$ (CAI)
- Utilization factor or plant use factor= Peak load/ Installed Capacity (0.4-0.9)
  (UF)
  $UF = \frac{Peak}{Inst}$
- Power Factor= Actual Power / Apparent Power(0.8-0.9)
- Diversity factor= Sum of maximum demand of individual consumers/ Simultaneous maximum demand on power station (>1)

8.2.1 Power and energy potentials

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- Demand Factor=Maximum demand on the power station/ Connected load (<1)

  (30) (50)

  - Q) A generating station has a connected load of 50 MW and a maximum demand of 30 MW. Determine the demand factor of the power station.
    - Demand factor= Maximum demand / Connected load =30/50 =0.6
- Reserve Factor= 1/ Utilization factor (1/UF)
- Relationship between LF, CF, and UF
  - $\boxed{CF=LF*UF}$

Inst= 100MW
peak= 70MW
time=1week.
Energy=5880000 KWhr

(Avg / Total)

C.F=? =?

$CF = \frac{Avg}{Inst} = \frac{35}{100} = 35\%$

Load factor=? (LF)

$L.F = \frac{Avg}{Peak} = \frac{35}{70} = 50\%$

Q) If peak load on a power plant having a capacity of 100 MW is 70 MW during a given week and energy produced is 5880000 KWh, the capacity factor for the plant for the week will be

a) 35% b) 50% c) 70% d) 65%

$\text{Avg Power} = \frac{\text{Energy}}{\text{time}} = \frac{5880000 \text{ KWhr}}{7*24 \text{ (hr)}}$ (kW)

$= 35000 \text{ kW}$

$= 35 \text{ MW}$

8.2.1 Power and energy potentials

peak = Inst

$L.F = \frac{Avg}{peak}$, Cap fact $(C.F) = \frac{Avg}{Inst}$

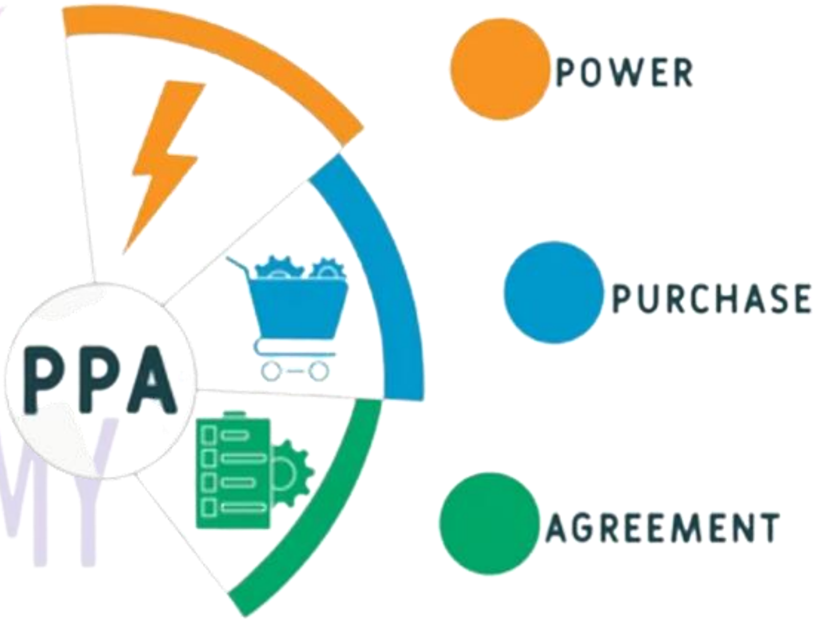
Some Important Information

- If peak load is equal to installed capacity of plant, then load factor is equal to plant or capacity factor
- The capacity factor for hydro- electric plant generally varies from 0.25 to 0.75.
- Utilization factor commonly varies from 0.4 to 0.9
- Power factor can never be greater than 1
- Diversity factor is always greater than 1
- Flow duration curve is also called as Discharge- Frequency curve.

8.2.2 Method of Fixing Installed Capacity

- The Design Discharge (Q) is decided based on the different percentile of exceedance of flow. Currently, NEA has set a criterion of fixing design discharge corresponding to a minimum of 40% probability of exceedance in order for a run-off-river hydropower project to be eligible for PPA.

In Nepal for projects up to 25MW, the installed capacity is fixed based on $\mathbf{Q_{40}}$, but for projects greater than 25MW, the installed capacity is fixed based on optimization study.



8.2.2 Method of Fixing Installed Capacity

There are 2 methods:

1. **Marginal Cost and Benefit Approach**:
2. **Optimization Approach**:

$P = \gamma Q H \eta$

$P\uparrow = \gamma Q_{40} H \eta \; (\downarrow)$ Rev $(\downarrow)$ cost $(\downarrow)$

$\gamma Q_{80} H \eta \; (\uparrow$ 40% Rev $(\uparrow)$

cost $\uparrow$

1. Marginal Cost and Benefit Approach

Project installed capacity is determined by comparing marginal costs and benefits and keeping fixed costs as same.

2. **Optimization Approach**:

Flow duration curves are studied and alternative project costs and benefits are studied to find the optimum capacity which becomes the installed capacity

8.2.2 Method of Fixing Installed Capacity

Economic Plant Capacity

- Marginal cost and benefit approach may be used to fix the installed capacity of plant.
- Economic installed capacity can be obtained by equating the marginal cost and benefits for the project.Where,

Marginal benefit= total energy generated annually * energy rate

=1kw*x%*1year*energy rate per MWhr=1/1000*365*24*rate

= 8.76 * x% * energy rate per MWhr

Marginal cost= annual variable cost+ operation and Maintenance cost

$$= V_{Cost}\left[\left(\frac{(1+i)^n * i}{(1+i)^n - 1}\right]\right. + \text{O\&M cost}$$

8.2.3 Types of Hydropower Plant

(A) Based on installed capacity:

According to prof. Emil Mosony:

i. Midget: < 100 Kw

ii. Low capacity: 100 to 1000 Kw

iii. Medium: 1 mw – 10 Mw

iv. High: > 10 Mw

According to Dandekar and Sharma:

- Micro upto 5000kw
- Medium capacity 5mw to 100 mw
- High -101mw to 1000mw
- Super capacity- > 1000 MW

8.2.3 Types of Hydropower Plant

But, in context of Nepal:

i. Micro hydro : < 100 KW

ii. Mini hydro : 100KW – 1000 KW (100kW - 1MW)

iii. Small hydro : 1 MW – 25 MW

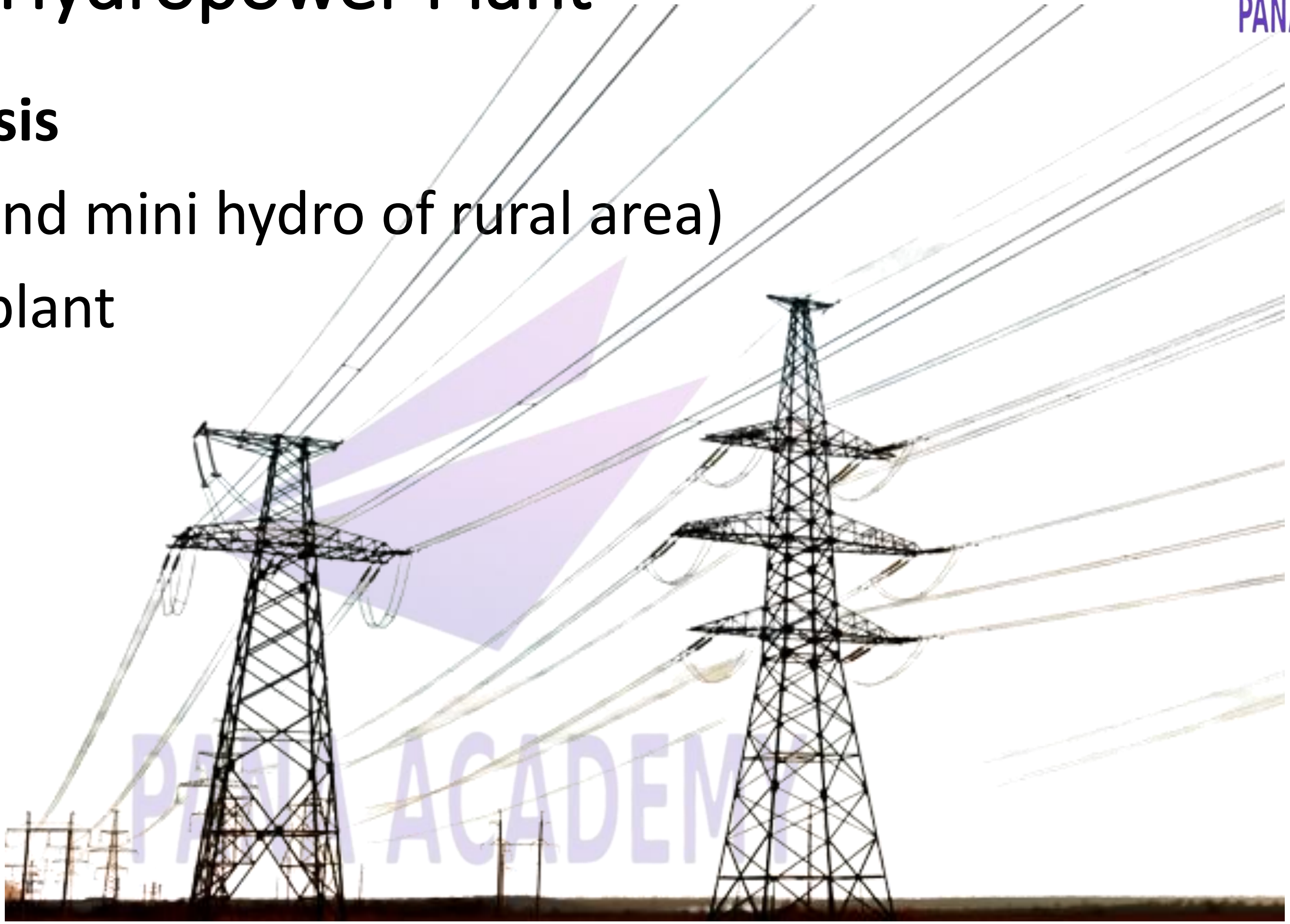
iv. Medium hydro: 25 MW – 100 MW

v. Large hydro: greater than 100 MW

8.2.3 Types of Hydropower Plant

(B) Functional basis

- Isolated (micro and mini hydro of rural area)
- Grid connected plant



8.2.3 Types of Hydropower Plant

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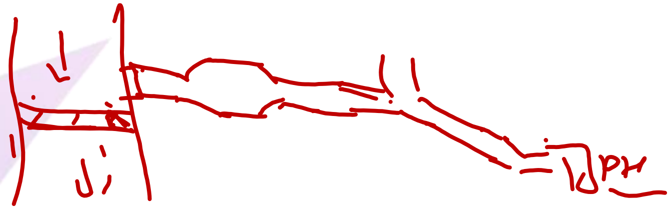
(C) Based on storage capacity:

i) Run off river type plants: (RoR)

The plants which don't regulate hydrograph of river in seasonal.

Eg. khimti, bhotekoshi, sunkoshi etc



ii) Peaking RoR type plants: (PRoR)

Keeping view of increased load during the peak hours RoR plants may be constructed with pondage which can regulate daily/weekly hydrograph to run the plant under full capacity.

Eg. Kaligandaki A, Marsyangdi, Middle Marsyangdi, Upper Tamakoshi

(144) (456)

8.2.3 Types of Hydropower Plant

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iii) Storage type:

Regulate the hydrograph of river by 1 or more seasons. Dam is constructed to create the storage reservoir that develops necessary heads for powerhouse.

Eg. Kulekhani HPP-60MW

Fig: Kulekhani II storage hydropower

8.2.3 Types of Hydropower Plant

iv) Pumped storage:

- Used when natural annual run-off is insufficient to satisfy the conventional hydroelectric installation (RoR, PRoR).
- Have reservoir at head and tail water which causes the water in u/s reservoir by pumping water from d/s reservoir using cheaper source of energy during off peak.
- Same water is utilized again and again.

8.2.3 Types of Hydropower Plant

D) Based on head

According (Mosonyi, Nava k.

i. Low head plant: < 50m
ii. Medium head plant: 50 – 300m
iii. High head plant: >300m

According to Ludin

i. Low head: < 15 m
ii. Medium head:15–50 m
iii. High head: > 50 m

8.2.3 Types of Hydropower Plant

- But, in context of Nepal:
    i. Very low head- upto 15m, propeller turbine, Kaplan turbine
    ii. Low head- 15-60m, Kaplan or Francis turbine
    iii. Medium head 60-150m, Francis turbine
    iv. High head 150-350m, Pelton or francis
    v. Very high head- greater than 350m, pelton turbine

high DB
Low head => kaplan
Medium head => Francis.

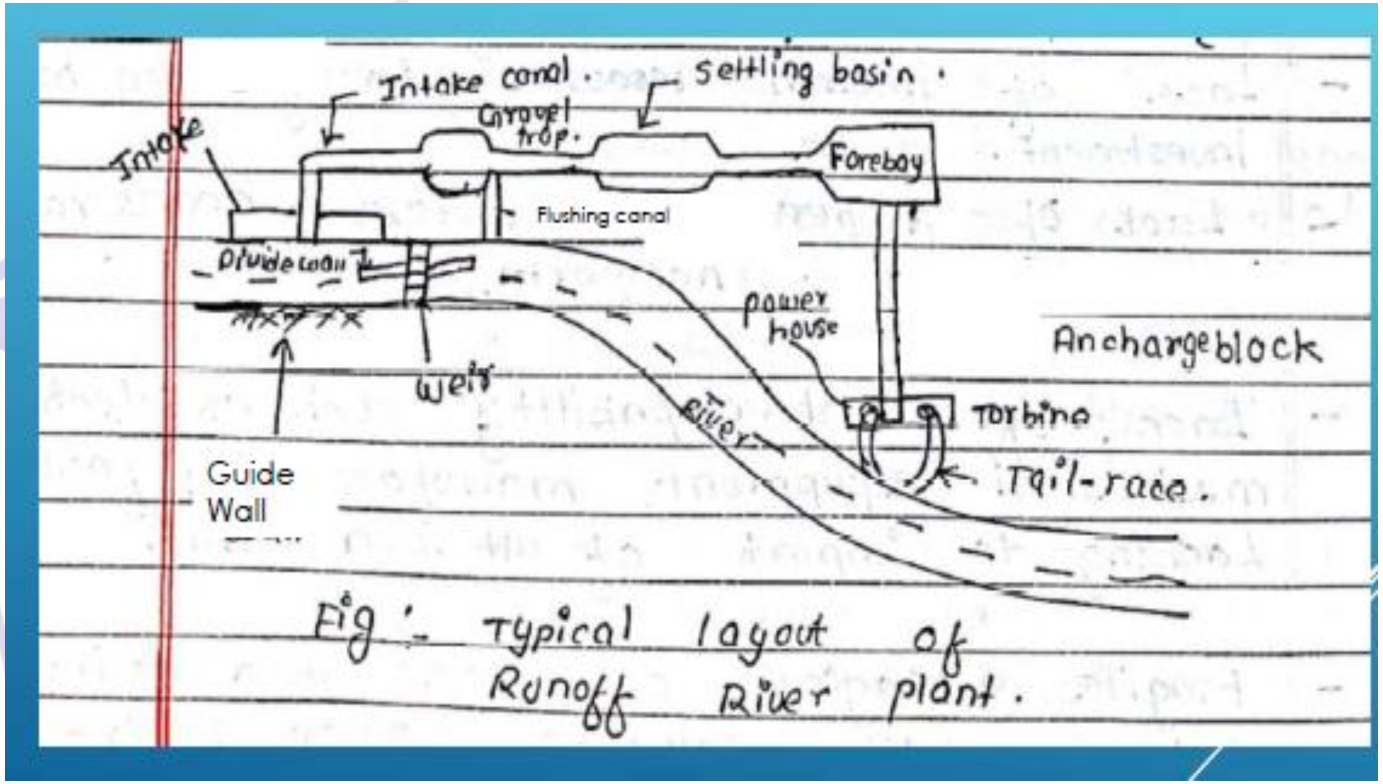
High head low DB = Pelton:

8.2.4 Components of Hydropower Plant

8.2.4 Components of Hydropower Plant

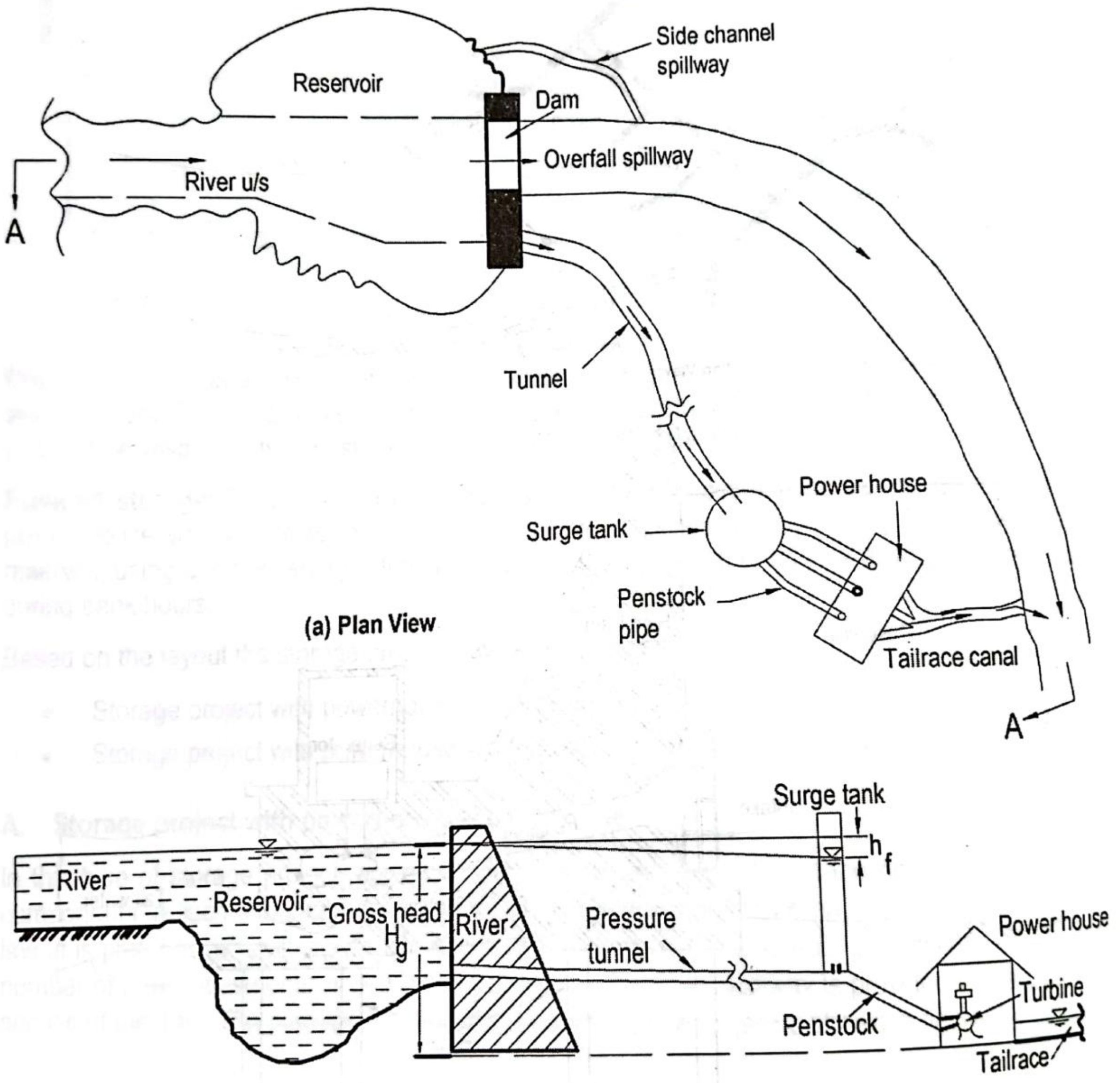
The major components of a hydroelectric plant are as follows.

1. Diversion Structure/Reservoir structure
2. Intake
3. Spillway
4. Gravel Trap
5. Settling Basin
6. Headrace Conveyance
7. Surge tank / Fore bay



8.2.4 Components of Hydropower Plant

8. Penstock
9. Anchor Block
10. Support Piers
10. Trash rack
11. Turbine
12. Draft tube
13. Tailrace



(a) Plan View

8.2.4 Components of Hydropower Plant

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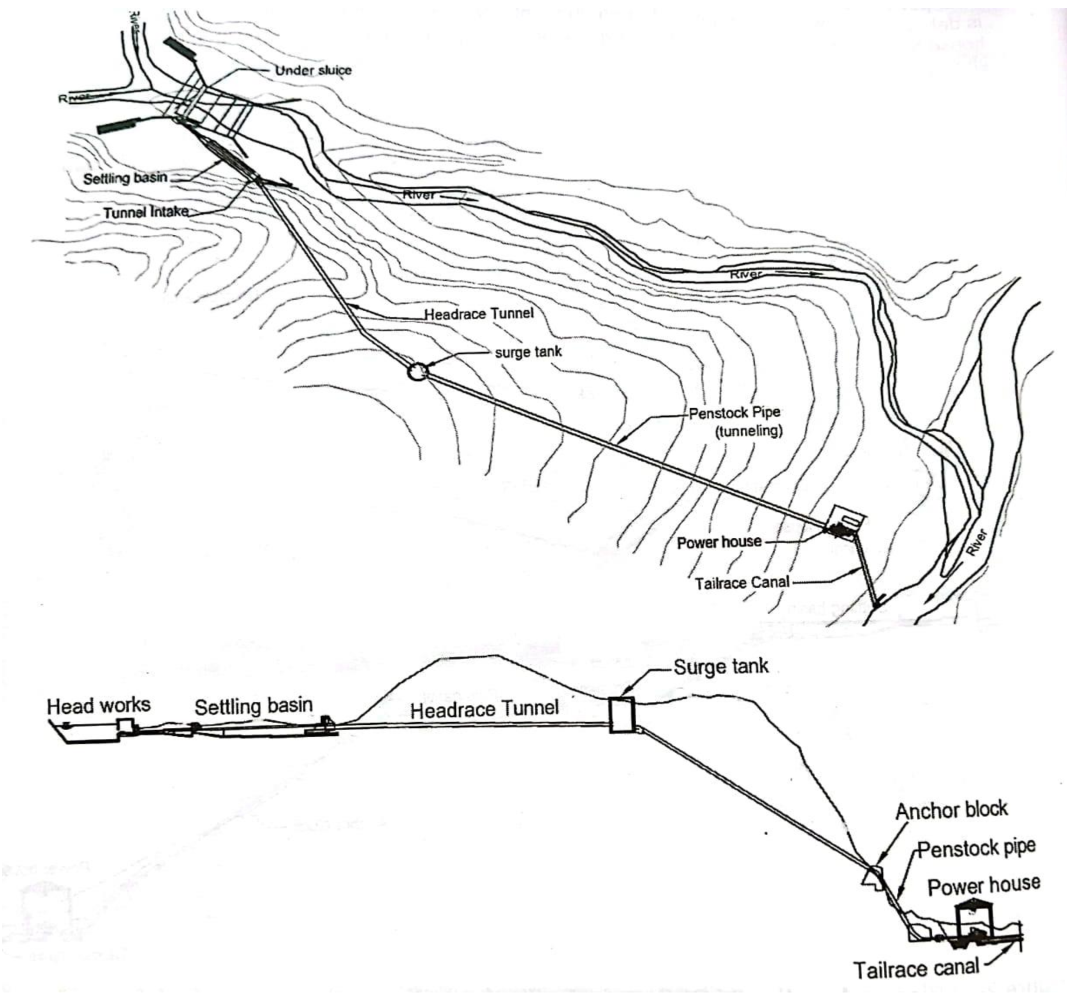
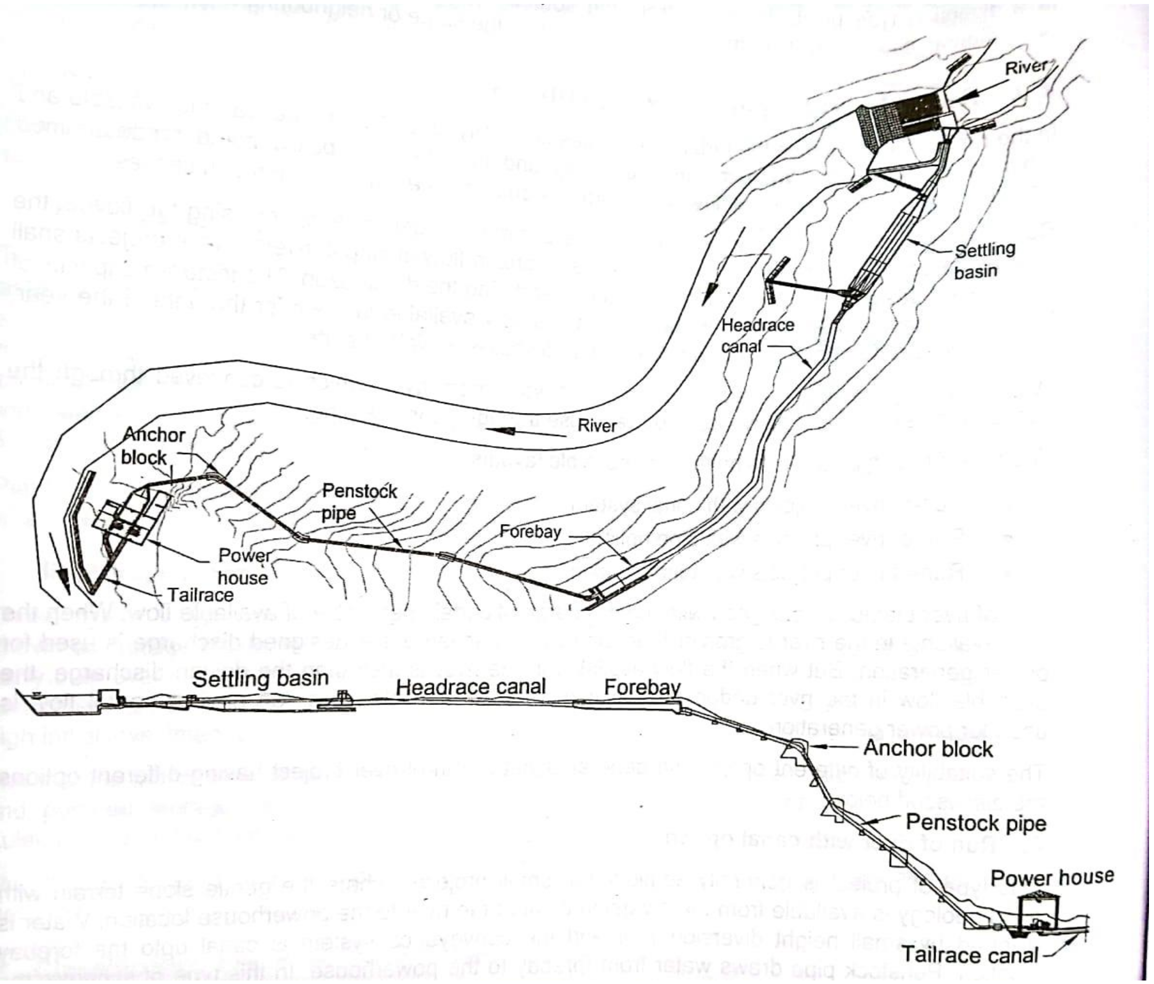




8.2.4 Components of Hydropower Plant

Diversion Structure: It is a structure that diverts water from the natural course of a river or stream to the intake of a hydropower project. Its primary function is to redirect water into the intake structure of the hydropower project.

Intake: It is a structure that collects water from the diversion structure and passes it on to the penstock. Its primary function is to regulate the flow of water to the hydropower plant and to prevent debris from entering the penstock.

Gravel Trap: It is a structure located upstream of the intake that removes gravel and other debris from the water before it enters the intake. Its primary function is to prevent damage to the intake and downstream components.

8.2.4 Components of Hydropower Plant

Settling Basin: It is a structure located downstream of the intake that slows down the velocity of water and allows sediment and other heavy particles to settle to the bottom. Its primary function is to remove sediment and other solids from the water before it enters the powerhouse.

Headrace Conveyance: It is a system of channels or pipes that transport water from the intake to the fore bay. Its primary function is to convey water from the intake to the fore bay.

Fore bay: It is a small reservoir located upstream of the powerhouse that receives water from the headrace conveyance system. Its primary function is to regulate the flow of water to the powerhouse and to provide a constant head of water for the turbines.

8.2.4 Components of Hydropower Plant

Surge Tank/Head Tank: It is a structure that absorbs pressure fluctuations in the penstock caused by sudden changes in the flow of water. Its primary function is to protect the penstock and other downstream components from damage.

Penstock: It is a large pipe that carries water from the forebay to the turbines in the powerhouse. Its primary function is to deliver water to the turbines with high pressure and velocity.

Anchor Block/Support Piers: It is a foundation structure that supports the penstock and prevents it from moving or shifting due to external forces. Its primary function is to anchor the penstock to the ground and provide stability.

8.2.4 Components of Hydropower Plant

Powerhouse: It is a building that houses the turbines, generators, and other electrical equipment. Its primary function is to convert the energy of falling water into electrical energy.

Tailrace: It is a channel or pipe that carries water from the powerhouse to the river or stream downstream. Its primary function is to release water back to the river or stream while maintaining the ecological balance and preventing erosion.

8.2.5 Reservoirs and their Regulation

- Reservoir is most commonly an enlarged natural or artificial lake created using a dam to store water. It has normally uncontrolled inflow but largely controlled outflow.

- The volume of water that can be stored in the particular reservoir is called reservoir capacity. It is calculated using topographical map, plotting area vs elevation by measuring contour elevation

8.2.5 Reservoirs and their Regulation

Fig: Phokshundo Lake

8.2.5 Reservoirs and their Regulation

- Efficient operation and management of reservoir
- Controls inflows and outflows from the reservoir

Purpose of Dam/Reservoir:

Dam is generally most suitable in hilly area where deep valleys are available which gives a deep storage of water. The stored water on its upstream side serves various purposes such as:

1. Flood Mitigation
2. Irrigation
3. Water Supply
4. Navigation
5. Fishery and wild life Preservation
6. Hydro-electric Power Generation
7. Recreation

8.2.5 Reservoirs and their Regulation

Functions of Regulation of reservoir

1. Ensure a steady water supply to the hydropower plant
2. Control downstream flooding
3. Meet downstream water demands
4. Maintain ecological balance
5. Optimize hydropower production
6. Control sedimentation
7. Provide recreational opportunities

8.2.5 Reservoirs and their Regulation

Location site for reservoir

The following are the things that should be considered while locating site for the reservoir,

- Located in an area of minimum percolation and maximum runoff
- Leakage in the area should be minimum to minimize the grouting works
- Should not be located in highly permeable rocks like shale, slates, gneisses, granite, etc
- Location should have a watertight rock base

8.2.5 Reservoirs and their Regulation

- To reduce the length of the dam, a narrow opening of the basin is essential
- Road accessibility to the site, to minimize construction cost
- Location should be free from objectionable minerals
- Location area should provide sufficient water depth with a smaller water area.
- Heavy silt-laden tributaries should not lead their discharge to the reservoir.
- Less submergence of habitat area, fertile land.

8.2.5 Reservoirs and their Regulation

Determining Storage Capacity

Reservoir capacity is the volume of water that can be stored in the particular reservoir. The methods used to determine reservoir capacity are:

1. By contour map
2. By mass curve of inflow and demand

8.2.5 Reservoirs and their Regulation

1. By contour map

A contour maps with areas A1, A2, A3,.... ,An enclosed by the successive contours can be determined with a planimeter. The capacity may be measured by taking contour at equal interval and totaling by trapezoidal or simpson's rule

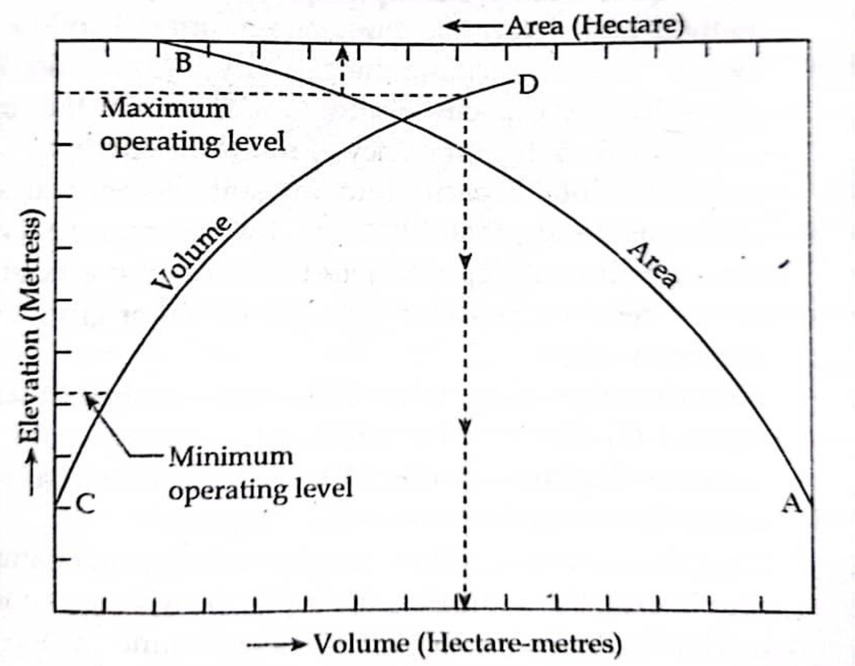
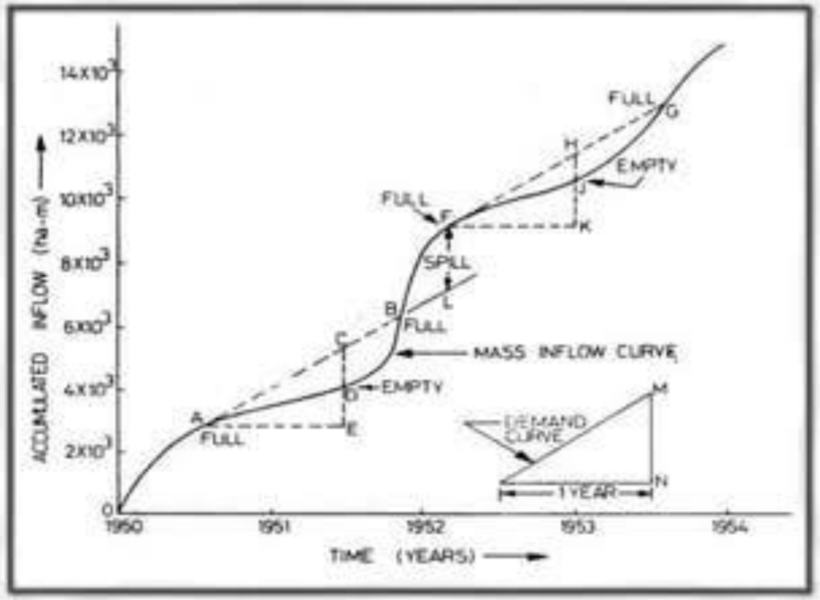


Figure: Area and Elevation storage Curve

8.2.5 Reservoirs and their Regulation

2. By mass curve of inflow and demand

A mass curve is the plot of accumulated flow in the stream with time. It is also known as Ripple Curve.



A mass curve is prepared from the flood hydrograph of inflow for large number of consecutive years.

The maximum vertical intercept between the mass curve gives the reservoir capacity.

8.2.5 Reservoirs and their Regulation

Reservoir Losses

1. Evaporation losses
2. Absorption losses
3. Reservoir leakage or percolation losses

Life of a reservoir:

- The term life of reservoir denotes the period during which whole or specified fraction of its total or active capacity is lost.
- The deposition of sediments gradually reduces the available storage capacity of the reservoir.

8.2.5 Reservoirs and their Regulation

i) **Bank Storage:** When the reservoir is filled, a certain amount of water seeps into the permeable reservoir bank. This water comes out when the reservoir gets depleted. This volume of water is known as bank storage.

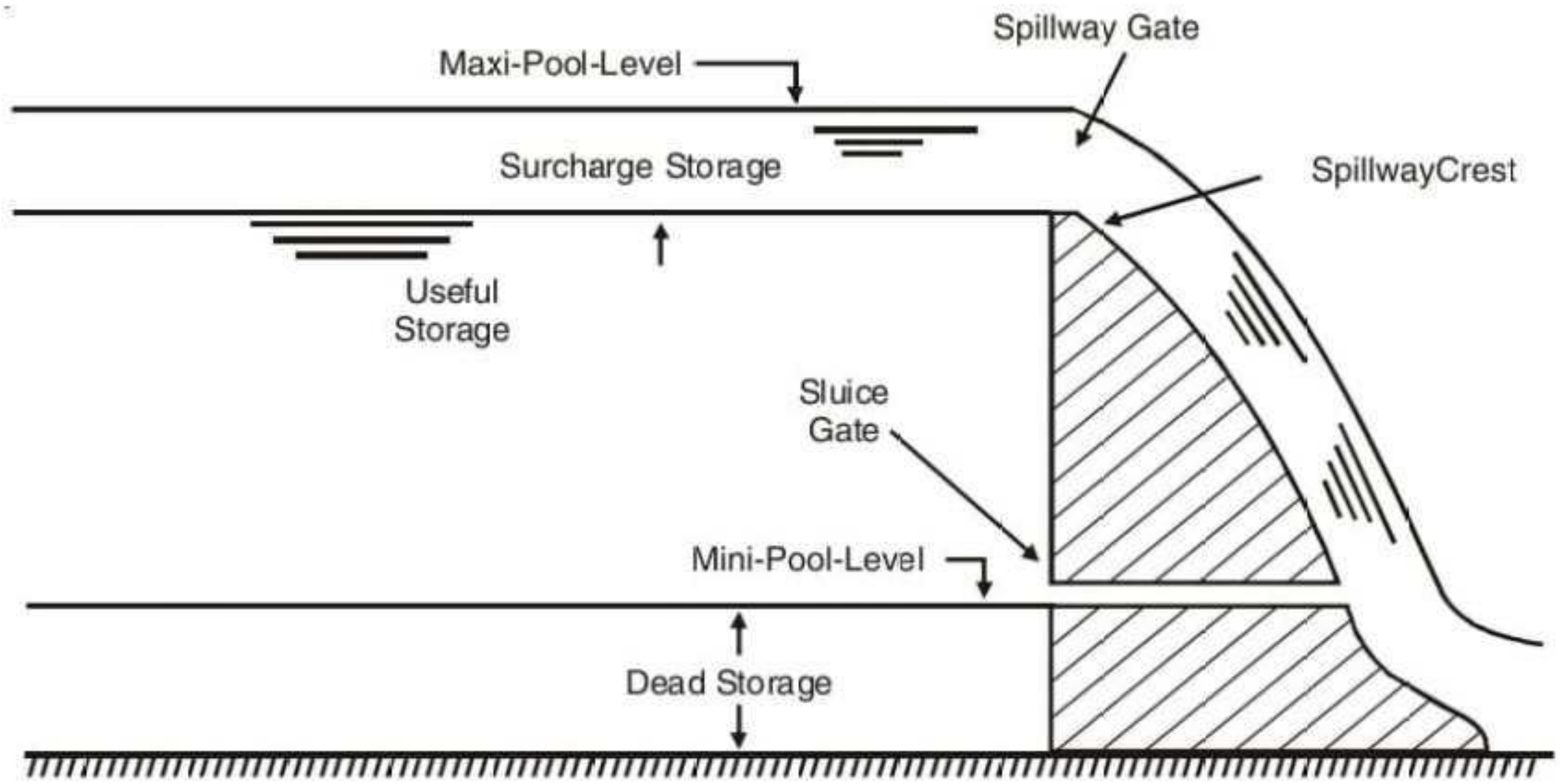
ii) **Useful storage:** The volume of water stored in the reservoir between normal and minimum pool level is called useful storage.

iii) **Surcharge Storage:** The volume of water stored between the maximum pool level and normal pool level is called surcharge storage.

iv) **Valley Storage:** Before the construction of the dam, a variable amount of water is stored in the stream channel is called valley storage. After construction of the dam, storage increases and there is a net increase in the storage is equal to the storage capacity of a reservoir minus natural valley storage.

Effective storage for flood mitigation = Live Storage + Surcharge Storage – Valleys Storage

8.2.5 Reservoirs and their Regulation



8.2.5 Reservoirs and their Regulation

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Trap efficiency (η):

- The reservoir trap efficiency is defined as the ratio of deposited sediment to the total sediment inflow for a given period within the reservoirs economic life time
- It is the percentage of sediment deposited in the reservoir measured even inspite of taking precautions and to control its deposition.

➢ η = Trap efficiency = Sediment deposited /Total sediment inflow

Most of the reservoirs trap 95 to 100% of sediment load flowing into them.

8.2.5 Reservoirs and their Regulation

Capacity inflow ratio(CIR):

It is the ratio of the reservoir capacity to the total inflow of water in it.

ie, capacity inflow ratio = capacity/inflow

It has found that the trap efficiency is the function of Capacity inflow ratio.

Trap efficiency (η) = f (capacity/inflow)

8.2.6 Load Analysis to the System

Load Curve chart illustrating variation in load over a specific time

- May be daily, monthly, and seasonally varying load curve

Load factor gives idea of cost per unit power generation

= average load/maximum demand

If the plant is in operation for T hours,

Load Factor = Average Load x T hours / (Maximum Demand x T hours)

Higher value of load factor higher average load or less maximum demand.

8.2.6 Load Analysis to the System

Average Load / Average Demand:

The average of loads occurring on the power station in given period (day or month or year) is known as average load or average demand.

Daily Average Load = No. of units (kWh)generated in a day / 24 hours

Monthly Average Load = No. of units (kWh) generated in a month/Number of hours in a month

Yearly Average Load = No. of units (kWh) generated in a year / 365*24 hours

Lets move to Multiple Choice Questions

8.2 Multiple Choice Questions

1. Which type of hydropower plant uses a dam to create a reservoir to store water for electricity generation?

a) Reservoir plant

b) Run-of-river plant

c) Pumped-storage plant

d) Tidal plant

2. Which type of hydropower plant uses the difference in water levels between high tide and low tide to generate electricity?

a) Tidal plant

b) Reservoir plant

c) Run-of-river plant

d) Pumped-storage plant

8.2 Multiple Choice Questions

3. Which type of hydropower plant is most commonly used for small-scale electricity generation in rural areas?

a) Micro hydropower plant

b) Reservoir plant

c) Tidal plant

d) Pumped-storage plant

4. Which type of hydropower plant is designed to operate continuously, with little or no fluctuation in output?

a) Base load plant

b) Peaking plant

c) Intermediate load plant

d) Pumped-storage plant

8.2 Multiple Choice Questions

5. The minimum power which a hydropower plant can generate throughout the year is called as ________________

a) power plant capacity

b) power plant load

c) firm power

d) water power

6. Hydroelectric power plant is

a) Non-renewable source of energy

b) Conventional source of energy

c) Non-conventional source of energy

d) Continuous source of energy

8.2 Multiple Choice Questions

7. What is the name of the process where water is pumped back into a reservoir when electricity demand is low?

a) Pumped storage

b) Tidal storage

c) Wave storage

d) Solar storage

8. What is the most common type of hydropower facility in ?

a) Run-of-river

b) Reservoir

c) Tidal

d) Wave

8.2 Multiple Choice Questions

9. The primary power at a hydro plant is determined considering

(a) 100% available flow

(b) minimum stream flow

(c) Available pondage

(d) all of above

10. Which of the following plant has minimum running cost

a) Diesel plant
b) Nuclear
c) Hydro
d) Steam

8.2 Multiple Choice Questions

11. Which of the following is not a requirement for site selection of hydroelectric power plant?

a) Availability of water

b) Large catchment area

c) Rocky land

d) Sedimentation

12. For high head hydro-electric plants, the turbine used is __________

a) Pelton wheel

b) Francis

c) Kaplan

d) All of the above

8.2 Multiple Choice Questions

13. The gross head minus the losses in friction, trash rack and other minor losses in penstocks is called

(a) Available head

(b) minimum head

(c) Effective head

(d) none of above

14. The ratio of maximum power utilized to the maximum power available is

a) power factor

b) plant use factor

c) reserve capacity

d) capacity factor

Note: The utilization factor(Plant use factor) is the ratio of the maximum power utilized to the maximum power available

8.2 Multiple Choice Questions

15. The net amount of power which is continuously available from a plant without any break is known as

a) firm power

b) secondary power

c) power factor

d) utilization factor

16. The value of power factor is generally.

a) equal to unity

b) less than unity

c) greater than unity

d) equal to zero

8.2 Multiple Choice Questions

17. To ensure maximum overall plant efficiency, the rated head should be equal to

a) Design head

b) Gross head

c) Operating head

d) Effective head

18. If the peak load for a power plant equals the plant capacity then the ratio of the capacity factor to load factor will be

a) 1

b) o

c) < 1

d) > 1

8.2 Multiple Choice Questions

19. The ratio of sediment deposited in the reservoir to the total volume of sediment carried by the river is

a. Trap efficiency
b. Sedimentation
c. Capacity Inflow ratio
d. Life of reservoir

20. The volume of water stored between normal reservoir level and maximum reservoir level is

a. Useful Storage
b. Live Storage
c. Surcharge Storage
d. Dead Storage

8.2 Multiple Choice Questions

21. The effective storage of a flood control reservoir is

a. The storage volume of flood water above the maximum reservoir level
b. The amount of water supplied from reservoir in a particular interval of time
c. The live storage plus the surcharge storage minus the valley storage
d. The storage between minimum and maximum reservoir levels under operating conditions

22. The correct sequence in direction of flow of water for installation in a hydropower plant is

a. Reservoir, surge tank, penstock, turbine
b. Reservoir, penstock, turbine, surge tank
c. Reservoir, surge tank, turbine penstock
d. Reservoir , penstock, surge tank, turbine

8.2 Multiple Choice Questions

23. The annual depreciation of a hydro power plant is about

a) 0.5% to 1.5%

b) 10% to 15%

c) 15% to 20%

d) 20% to 25%

Answer: 0.5% to 1.5%

24. Which of the following method is utilized for fixing installed capacity of Hydropower plant?

a) Demand Supply Approach

b) Rule curve Approach

c) Mass Analysis Approach

d) Marginal Cost Benefit Approach

8.2 Multiple Choice Questions

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25. Which stage of hydropower development involves detailed engineering design, procurement, and construction?

a) Pre-feasibility stage
b) Feasibility stage
c) Operation and maintenance stage
d) Construction stage

26. Which act provides for the establishment of the Nepal Electricity Authority (NEA)?

a) Electricity Authority Act
b) Hydropower Act
c) Energy Act
d) Renewable Energy Act

Nepal Electricity Authority (NEA) was created on August 16, 1985 (Bhadra 1, 2042) under the Nepal Electricity Authority Act. 1984, through the merger of the Department of Electricity of Ministry of Water Resources, Nepal Electricity Corporation and related Development Boards.

8.2 Multiple Choice Questions

27. Which factor determines the head available for power generation in a hydropower plant?

a) The difference in elevation between the water source and the turbine

b) The distance between the water source and the turbine

c) The size of the penstock

d) The diameter of the turbine blades

28. What is the highest elevation of water level that can be maintained in the reservoir without any spillway discharge either with gated or non-gated spillway?

a) Normal Water level

b) Minimum Water level

c) Weighted average level

d) Operating head

8.2 Multiple Choice Questions

29. The load on a hydel plant varies from a minimum of 10,000 kW to a maximum of 35,000 kW. Two turbo-generators of capacities 20,000 kW each have been installed. Calculate Plant factor.
    a) 50%
    b) 51%
    c) 56%
    d) 59%

30. If the peak load on a power plant having a capacity of 100 MW is 70 MW during a given week and the energy is 58, 80,000 KWH, the capacity factor for the plant for the week will be
    a) 35%
    b) 50%
    c) 70%
    d) 65%

8.2 Multiple Choice Questions

31. During a certain week a power plant turns out 84,00,000 kWh and the peak load during the week is 100,000 kW. What is the load factor during the week?
    - a) 40%
    - b) 45%
    - c) 50%
    - d) 60%

32. Calculate utilization factor if the maximum power utilized is 40,000 kW and two turbo generators installed each of capacity 23,000 kW.
    - a) 73%
    - b) 87%
    - c) 57.5%
    - d) 63%

8.2 Multiple Choice Questions

33. Determine the trap efficiency of reservoir if over a period of 10 years, the total sediment flowing into the river was 25000m3 while the total sediment that reached the downstream of river was just 5000m3.

a. 60%

b. 20%

c. 80%

d. None of the above

34. A hydroelectric generating station is supplied from a reservoir of capacity 6 million m^3 at a head of 170 m. Determine the potential energy stored in this water.

a. 10^10 J

b. 10 ^ 9 J

c. 10 ^ 8 J

d. 10 ^ 12 J

8.2 Multiple Choice Questions

35. The maximum power output of a hydropower plant is 5 MW, and its load factor is 0.8. What is the average power output of the plant?

a) 4 MW

b) 4.5 MW

c) 5 MW

d) 6 MW

36. In a hydropower plant of installed capacity 100MW, 42GWh energy is produced in one month What is the approx. capacity factor of that plant?

a) 56%

b) 58%

c) 60%

d) 64%

THANK YOU