IQRA National University, Peshawar
Department of Electrical Engineering
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Power Generation

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Terminal Examination *course Instructor: Engr.Sanaullah Ahmad*

Note: Attempt all Questions & Draw diagrams where necessary.

Question No 1 ***20***

A. With the help of a diagram show different Elements of a Hydropower Plant? CLO 1
B. Water for a small hydroelectric station is to be made available from a pondage with a volume of $5 \times 10^5 m^3$ located at a height uphill to provide water at a head of 100m at a hydraulic efficiency of 85% If the electrical efficiency is 94% and the water supply is available for 8 hours daily, determine the capacity of the generator to be installed at the power station. CLO 2

Question No 2 ***20***

A. Classify different hydropower turbines, what are the parameters required for the selection of hydropower turbines? CLO1
B. Select a suitable turbine for a hydropower scheme with available head height of 190m and rated discharge of 2.2 m^2/s with overall efficiency of 85%? Also determine turbine diameter and jet diameter? Specific speed $Ns = 85.49/(h)^{0.243}$. $Diameter = 38.56\sqrt{h}/n$. *Jet Diameter* $q = (\prod dj^2)Vj/4$ *where* $Vj = \sqrt{2gh}$ CLO 2

Question No 3 ***10***

Explain different stages of Nuclear Fuel Cycle? CLO 1

☺ GOOD LUCK ☺

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Q No 1

Part A. **Different Elements of hydro Power Plant.**

* Reservoir
* Dam
* Trace rack
* Forebay
* Surge tank
* Penstock
* Spillway
* Turbine
* Power house

* **Reservoir.**

A reservoir is employed to store water which is further utilized to generate power by running the hydroelectric turbine

Dam: A dam is a barrier which confines or raise water for stage or diversion to create a hydraulic head.

Dam are generally made of concrete, stone masonry, Rockfill or Timber..

Trace rack:

Water conveyed from forebay to penstocks through intake structure

+ Main component are trash rack and gate
+ Trash rack prevent entry of debris

Fore bay:

The forebay serves as regulating reservoir storing water temporarily during light load period and providing the same for initial increase on account of increasing load.

Surge tank.

Additional state for near to turbine, usually provided in high head plants.

Located near the beginning of the penstock.

Penstock:

Penstock are the water conductor conduit of suitable size connecting the surge shaft to inlet valve.

It allow water to the turbine through main invulet valve.

Spillway:

Excess accumulation of water endangers the stability of dam construction. Also in order to avoid the overflow of water out of the dam.

Turbines:

Turbines are used to convert the energy water of falling water into mechanical energy.

Water turbine is a rotary engine that takes energy from moving water

Power house:

The power house is a building in which the turbines, alternators and the auxillary plant are housed.

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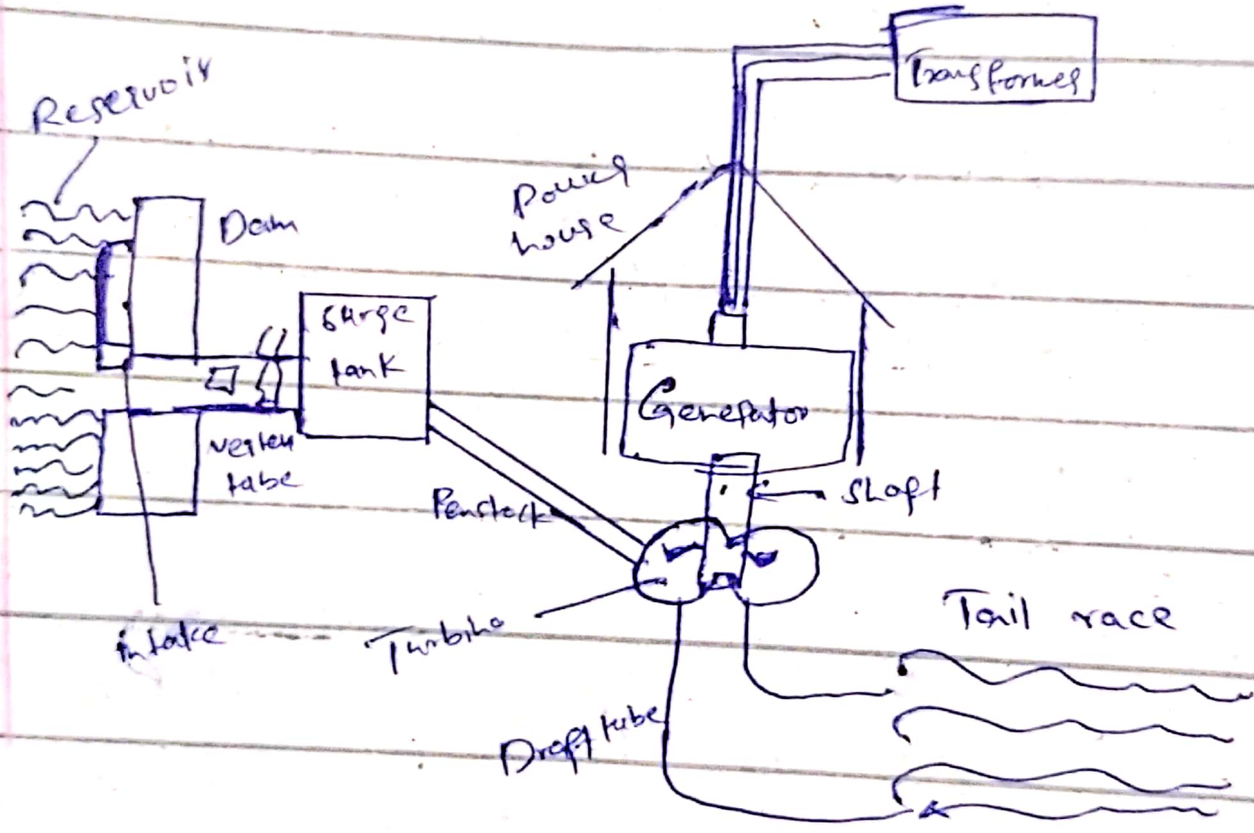


Hydro power Plant

Q.No 1

Part B.

Solution:

Given that:

Available Volume at Pondage: $\forall = 5 \times 10^3\ m^3$

Available head ; $h = 100m$

Hydraulic efficiency; 85% ⇒ 0.85

Electrical efficiency: 0.94

Therefore overall efficiency. 0.85×0.94

$= 0.80$

Using $E = \rho g h V$

$= 0.8 \times 100 \times 9.81 \times 100 \times 5 \times 10^5$

$E = 3.92 \times 10^{11}$ W-s

QNo.2
Part A

Different hydropower turbine:

* Impulse Turbine
The impulse turbine generally uses the velocity of the water to move the runner and discharges to atmospheric pressure. The water stream hits each bucket on the runner. There is no suction on the down side of the turbine and the water flows out of the bottom of the turbine housing after hitting the runner. An impulse turbine is generally suitable for high head. low flow application.

* Pelton:
A pelton wheel has one or more free jets discharging water into

an aerated space and impinging on buckets of a runner. Draft tubes are not required for impulse turbine since the runner must be located above the maximum tailwater to permit operation at atmospheric pressure.

* Cross - flow.

A cross-flow turbine is drum - shaped and uses an enlongated rectangular section nozzle directed against curved vanes on a cylindrically shaped runner. It resembles a "squirrel cage" blower. The cross-flow turbine allows the water to flow through the blades twice. The first pass is when the water flows from the outside of the blades to the inside back out. the second pass is from the inside back out. The Cross Flow was developed to accommodate larger water flows and lower heads than the pelton.

★ **Reaction Turbine:**

A Reaction turbine develops power from the combined action of pressure and moving water. The runner is placed directly in the water stream flowing over the blades rather than striking each individually. Reaction turbines are generally used for sites with lower head and higher flows than compared with the impulse turbines.

Propeller:-

A propeller turbine generally has a runner with three to six blades in which the

Water contacts all of the ~~above~~ blades constantly. picture a boat propeller running in a pipe. through the pipe. the pressure is constant if it isn't the runner would be out of balance. The pitch of the blades may be fixed or adjustable The major components beside the Runner are scroll case, wicket gates, and a draft tube. There are several different types of propeller turbines.

Q.No 2

Part B.

Given data

$h = 190m$

$Q = 20 m^3/s$

$\xi = 85\%$

$N_s = 85.49 (h)^{0.243}$

Diameter $= 38.56 \sqrt{h}/n$

jet Diameter $q = (\pi d_j^2) v_j/4$

$V_j = \sqrt{2gh}$

Solution.

We know that

Diameter $= 38.56 \sqrt{h}/m$

$= 38.56 \times 16.216$

$D = 625.2889 6m$

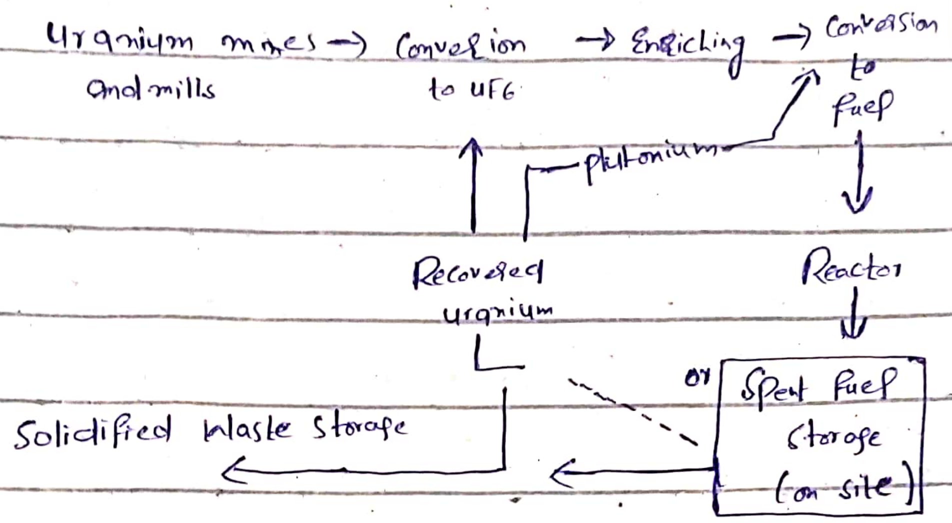
jet diameter $= q = (\pi d_j^2) v_j/4$

$q = (3.14 \times 625.288) 61.02/4$

$q = 29951.7$

Q.No 3

Ans) Different stage of Nuclear fuel cycle



The nuclear fuel cycle also called nuclear fuel chain is the progression of nuclear fuel through a series of differing stages. It consist of steps in front end which are the preparation of the fuel, steps in the service period in which the fuel is used during reactor operation and step in the back end which are necessary to safely manage, contain and either

Mining and Milling

* Uranium is usually mined by either surface (open cut) or underground mining techniques, depending on the depth at which the ore body is found.
* From these, the mined uranium ore is sent to a mill which is usually located close to the mine.
* At the mill the ore is crushed and ground to a fine slurry which is leached in sulfuric acid to allow the separation of uranium from the waste rock.
* It is then recovered from solution as uranium oxide (U_3O_8) concentrate (Sometime this is known as (yellow cake))

Conversion :

* Because uranium needs to be in the form of a gas before

it can be enriched, the UO_2 is Converted into gas uranium hexafluoride (UF_6) at a Conversion plant

Enriching:

* Need to enrich uranium to at least 3% for a power plant
* Two Method of Enriching
* **Gaseous Diffusion Method.**

  - UF_6 (hexafluoride) gas heated
  - U-238 is heavier than U-235
  - Hexafluoride Gas can be Separated into two streams
    * Low Velocity U-238
    * High Velocity U-235

* Centrifuge Method
  - Gas Spun in Centrifuge
  - Lighter U-235 Will Separate from heavier U-238.

- Hexa flouride Gas can be separated into two stream.
  - + Low velocity U-238
  - + High velocity U-235

* (b) Centrifuge Method:

- Gas spun in centrifuge
- Lighter U-235 will separate from heavier U-238

Fuel Conversion:

* Enriched uranium transported to a fuel fabrication plant where it is converted to uranium dioxide (UO_2) powder and pressed into small pellets.
* These pellets are inserted into thin tubes usually of a zirconium alloy or stainless steel, to form fuel rods.

* The rods are then sealed and assembled in clusters to form fuel assemblies for use in the core of the nuclear reactor.

Fuel packaging in the core

* Rods contain uranium enriched
* Need roughly 100 tons per year for a 1000mw plant.

The Reactore Core

The reactor core consists of fuel rods and control rods

- fuel rods contain enriched uranium
- Control rods are inserted b/w the fuel rods to absorb neutron and slow the chain reaction.

* Control Rods are made of Cadmium which absorb neutrons effectively.

Moderators:

* Neutrons produced during fission in the core are moving too fast to cause a chain reaction.
* A moderator is required to slow down the neutrons
* In nuclear power plant water or graphite acts as the moderator.