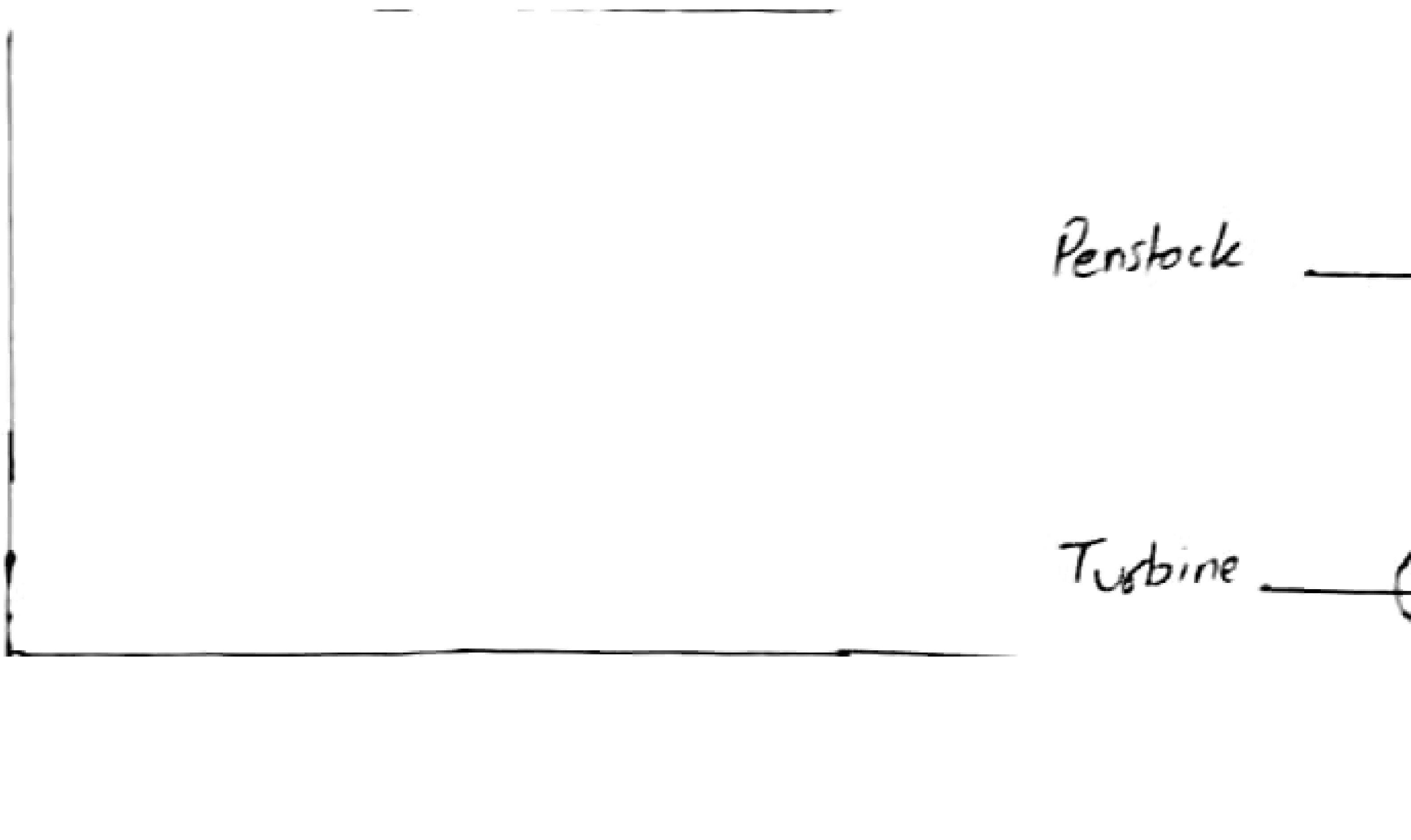
Penstock
Turbine

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(2)

Q. 1

B :-

Given that:

Available volume at pondage: $V = 5\times10^5\ m^3$

Available head: $h = 100\ m$

Hydraulic efficiency: 85% 0.85

Electrical efficiency: 0.94

Therefore: Overall efficiency $0.85\times0.94 = 0.80$

Using $E = \eta\rho g h V = 0.8\times1000\times9.81\times100\times5\times10^5$

$E = 3.92\times10^{11}$ W-s

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(3)

Q.2

PART: A

It is a rotatry mechanical device that extracts energy from a fluid flow and converts it into useful work.

The work produced by a turbined can be used for generating electrical power when combined with a generator.

There are two main types of hydro power turbines.

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Reaction Turbines: A reaction turbines 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 individially reaction turbine are generally used for sites with lower head and higher flows than compared with the impulse turbines.

Following are the parometers of the selection of hydropower turbines

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1) Total Height of the water head.

2) Water flow
3) Total volume of the water
4) Deepness of the turbine installation.
5) Efficiency
6) Cost Effectiveness.

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Q.2

Part B:-

Given data:-

Head = h = 190m

Discharge = q = 2.2 m^3/s

Overall Efficiency = η = 85% or 0.85

Using the formula to calculate specific speed

$$n_s = \frac{85.49}{(h)^{0.243}}$$

$$n_s = \frac{85.49}{(190)^{0.243}} = 23.88 \text{ rpm}$$

Using "$P = \eta \rho q g h$" to Obtain

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POWER GENERATION:

power out put

$$P = 0.85 \times 1000 \times 2.2 \times 9.81 \times 190$$

$$= 3485.5 \text{ KW}$$

$$n = ns = 23.88 \times \frac{(190)^{3/4}}{\sqrt{3485.5}}$$

$$= 285.32 \text{ rpm}$$

The number of poles required are computed by

$$Ns = \frac{120f}{P}$$

$$P = \frac{120 \times 50}{285.32}$$

$$P = 21.02 \text{ poles.}$$

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We will select 24 poles which will rotate at 250 rpm at 50 Hz. So the turbine will at have diameter which can be calculated by.

$D = 38.567 \sqrt{\frac{4}{n}} = 38.567 \sqrt{\frac{190}{250}} = 2.18m$

for calculating Jet diameter

$q = \pi \; dg^2 \; (vg)/4$

Jet velocity $= V_J = \sqrt{2gh} = \sqrt{2 \cdot 9.8 \times 190}$
$= 61.05$ m/sec

There for Jet diameter will be

$dj = \sqrt{\frac{4q}{\pi v_j}} = \sqrt{\frac{4 \times 2.2}{3.14 \times 61.05}}$

$dj = 21.4m$

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Q.3

Sol:-

DIFFERENT STAGES OF NUCLEAR FUEL CYCLE:-

Mining and Milling:-

- Uranium is usually mined by either surface (open cut) or under-ground 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

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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
  - Some times is known as "yellow cake".

CONVERSION:-

- Because uranium needs to be in the form of a gas before it can be enriched. The U_3O_8 is converted into the gas uranium hexafluoride (UF_6) at a conversion plant.

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ENRICHING:-

- Need to enrich uranium to at least 3% for a power plant.

- Two Methods of ENRICHING
- Gaseous diffusion Method:-

  - UF_6 (hexafluoride) gas heated
  - U-238 is heavier the U-235
  - Hexafluoride gas can be separated into two streams
    - Low velocity U-238
    - Low velocity U-235

- Centrifuge Method:-

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

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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 assemblies for use in the core of the nuclear reactor.

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FUEL PACKAGING IN THE CORE:-

- Rods contain uranium enriched.
- Need roughly 100 ton per year for a 1000 MW plant.

The Reactor Core.

The reactor core consists of fuel rods and control rods

- Fuel rod contain enriched uranium
- Control rods are inserted b/w the fuel rods to absorb neutrons and slow the chain reaction

Control rods are made of cadmium. which absorb neutrons effectively.

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Moderators:-

- Neutron 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 plants water or graphite acts as the moderator.

Light Vs. Heavy water:-

- 99.99% of water molecules contain normal hydrogen (i.e. with a signal proton in the nucleus)
- Water can be Specially prepared

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So that molecule contain deut-erium (i.e hydrogen with a proton and a neutron in the nucleus

- Heavy water is a much better moderator but is very expensive to make

Boiling Water Reactions:-

- Heat generated in the core is used to generated steam through a heat exchanger

- The steam runs a turbine just like a normal power plant.

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Pressurized water Reactors-

- Water in the core heated top 315°C but is not turned into steam due to high pressure in the primary top.

- Heat exchange used to transfor heat into secondary loop where water is turned to steam to power turbine.

- Steam used to power turbine never comes directly in contact with radioactive materials.

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Uranium Reprocessings-

- most of the spent fuel can be reprocessed.
- federal law prohibits commerical reprocessing b/c it will produce plutonium be used both as a fuel and in constracting bombs).

Comparing Uranium to Coals-

* 1 kg of uranium - 235 will generai as much energy as 3,000 tons of coal without CO_2 emissions.