IQRA National University, Peshawar Department of Electrical Engineering

Name: __M waqar Hameed

ID______6939________

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Power Generation

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

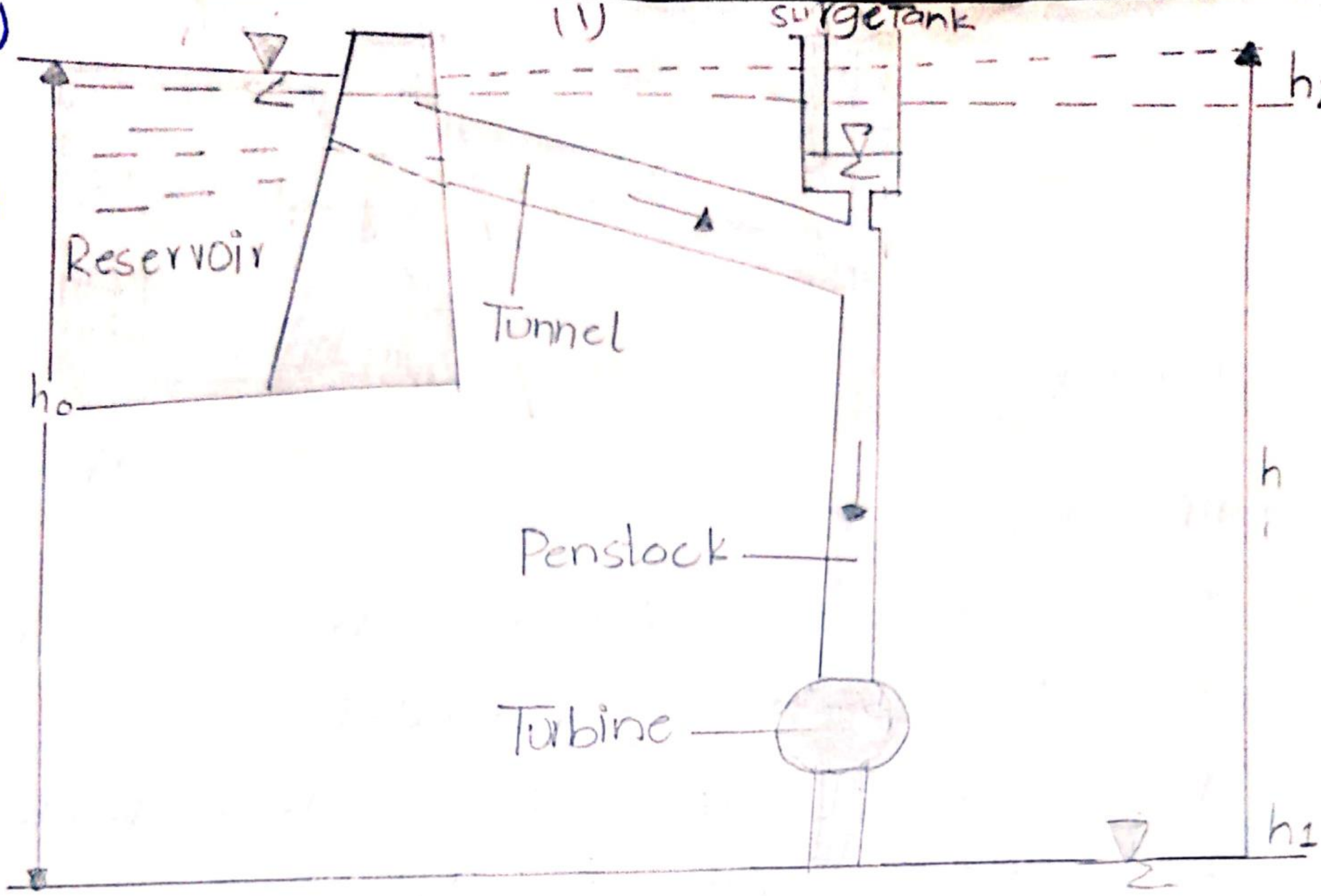
Question No 2 ***20***

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 h/ . Jet Diameter $q= (\prod dj^2)Vj/4$ where $Vj = 2\ h$ CLO 2

Question No 3 ***10***

Explain different stages of Nuclear Fuel Cycle? CLO 1

Q 1)
art
(a)



Reservoir:
The dam is Constructed on a large river in hilly areas to ensure sufficent Water Storage at height. The dam forms a large reservoir behind it. the height of Water level in the reservoir determines how much to Potential energy is Stored in it.

Penstock:

A Penstock is a huge Steel Pipe Which Carries Water from the reservoir to the turbine Potential energy of the Water is Converted into Kinetic energy as it flows down through the Penstock due to gravity.

Surge tank:

Surge tank are usually Provided in high or medium head Power Plants When Considerably long Penstock is required. A Surge tank is a Small reservoir or tank Which is open at the top. It is fitted b/w the reservoir and the Power house. The Water level in the Surge tank ~~the~~ rises or falls to reduce the Pressure Swings in the Penstocks When there is Sudden reduction in load on the turbine, the governor closes the gates of the turbine to reduce the water flow. This causes pressure to increase abnormally in the penstock. This is prevented by using a surge tank. in which the water level ~~res~~ rises to reduce the pressure. On the other hand surge tank provides excess water needed when the gates are suddenly opened to meet the increased load demand.

Water Turbine:.

Water from the penstock is taken into the water turbine. The turbine is mechanically coupled to an electric generator. Kinetic energy of the water drives the turbine and consequently the generator gets driven.

There are two main types of water turbine
i) impulse turbine ii) Reaction Turbine

impulse turbines are used for large head and reaction turbines are used for low and medium heads.

Q (1) Part B 14

Solution:..

Given data:

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

Available head $h = 100m$

Hydraulic efficiency $= 85\% = 0.85$

Electrical efficiency $= 0.94$

Solution:

Overall efficiency $= 0.85 \times 0.94 = 0.80$

Using $E = \eta \rho g h V = 0.8 \times 1000 \times 9.81 \times 5 \times 10^5$

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

Q2 Part (a)

Answer:

Turbine:

Turbine is a rotatory mechanical device that exhest energy from a fluid flow and Convert it into useful Work

Types:

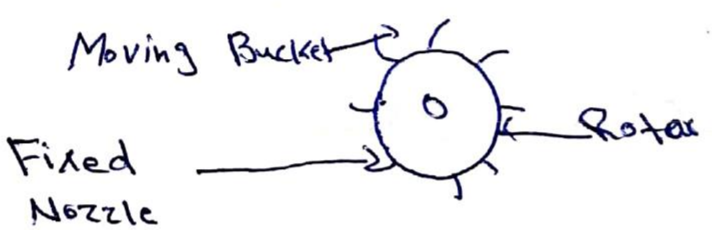
i) Impulse Turbine ii) Reaction Turbine

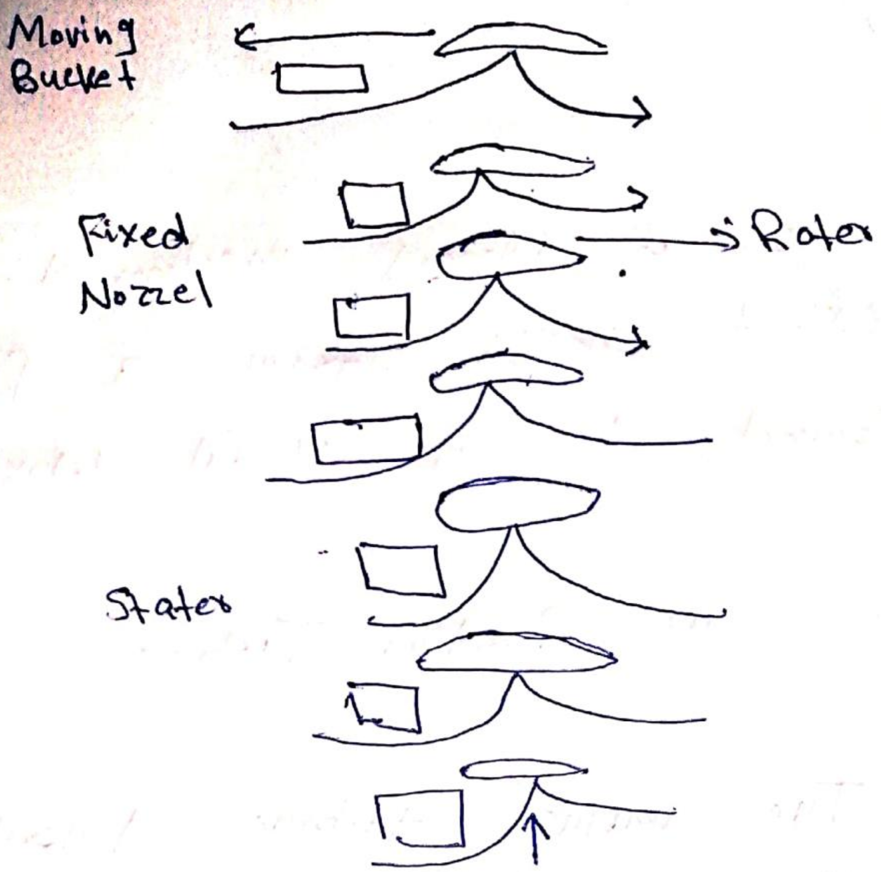
Impluse Turbine:

The impluse turbine generally uses the Velocity of the water to move the runner. The water Stream hits each bucket on the runner.

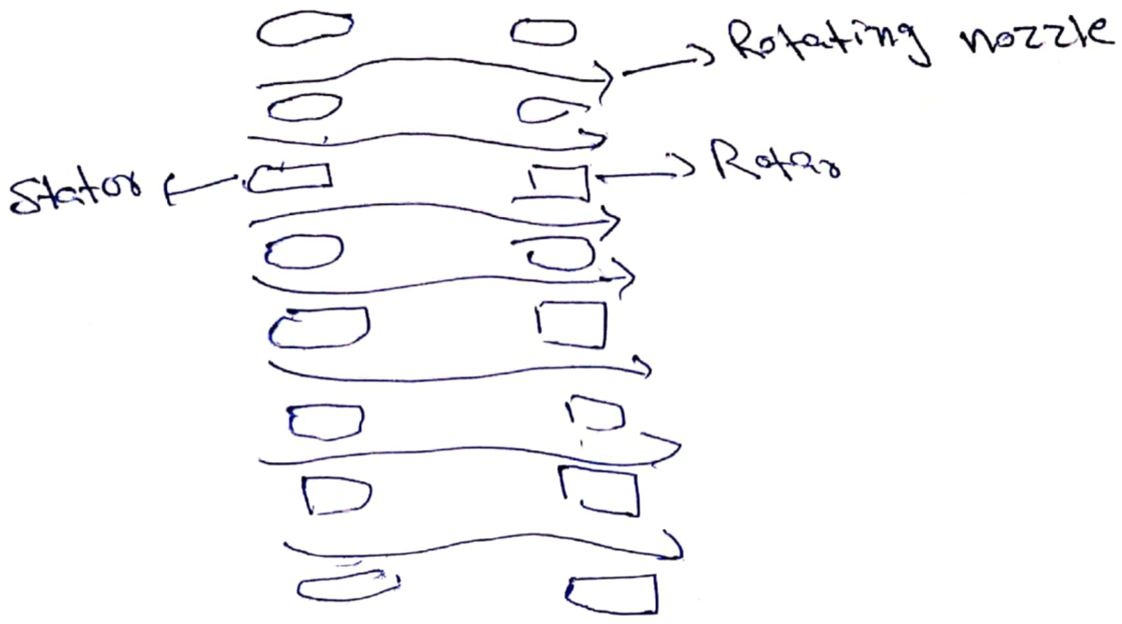
An Impluse turbine is generally suitable for high ~~lead~~ head low flow application.

In impluse turbine at inlet only Kinetic energy available. But in reaction turbine at inlet kinetic energy as well as Pressure energy both are available





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 individualy used for sites with lower head and higher flows than compared with the impulse turbines



Parameter the following Parameter are used for HydroPower Plant.

1) Height of Standing Water "Head"
2) Flow of Water
3) Volum of Water
4) How deep the turbine must be Set
5) Efficiency
6) Cost

Q 2 Part (2)

Given that:

Head $h = 190 m$

Discharge $q = 2.2 m^3/s$

Overall efficiency $= \eta = 85\% = 0.85$

At a head of 190 meters a single jet Pelton Wheel turbine seems most suitable Therefore from table the Specific Speed can be Calculated by using

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

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

The output Power can be obtained by using.

$P = \eta \rho q g h$ Watts

$P = 0.85 \times 1000 \times 2.2 \times 9.81 \times 190 = 3486.5 \text{ KW}$

using equation we have

$$n = n_s \frac{h}{\sqrt{P}} = \frac{23.88 \times (190)}{\sqrt{3485.5}} = 285.32 \text{ rpm}$$

An alternator related at 50 HZ frequency with Synchronous Speed approaching 285.32 rpm but not greater is to be Selected. The number of Poles required are Computed by using.

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

$$P = \frac{120 \times 50}{285.32} = 21.02 \text{ Poles}$$

Selecting 24 Poles alternator will rotate at 250 rpm at 50Hz Seems Just right

$$D = 38.567 \frac{\sqrt{6}}{n} = 38.567 \times \frac{\sqrt{190}}{250} = 2.12m$$

The Jet diameter Can be calculated by using equation

$$q = \pi dj^2 (vs/u)$$

Jet Velocity = $V_J = \sqrt{2gh} = \sqrt{2.9.8 \times 190}$

$$= 61.05 \text{ m/sec}$$

Therefore Jet diameter Will be

$$dJ = \sqrt{\frac{4q}{\pi Vj}} = \sqrt{\frac{4 \times 2.2}{3.14 \times 61.05}}$$

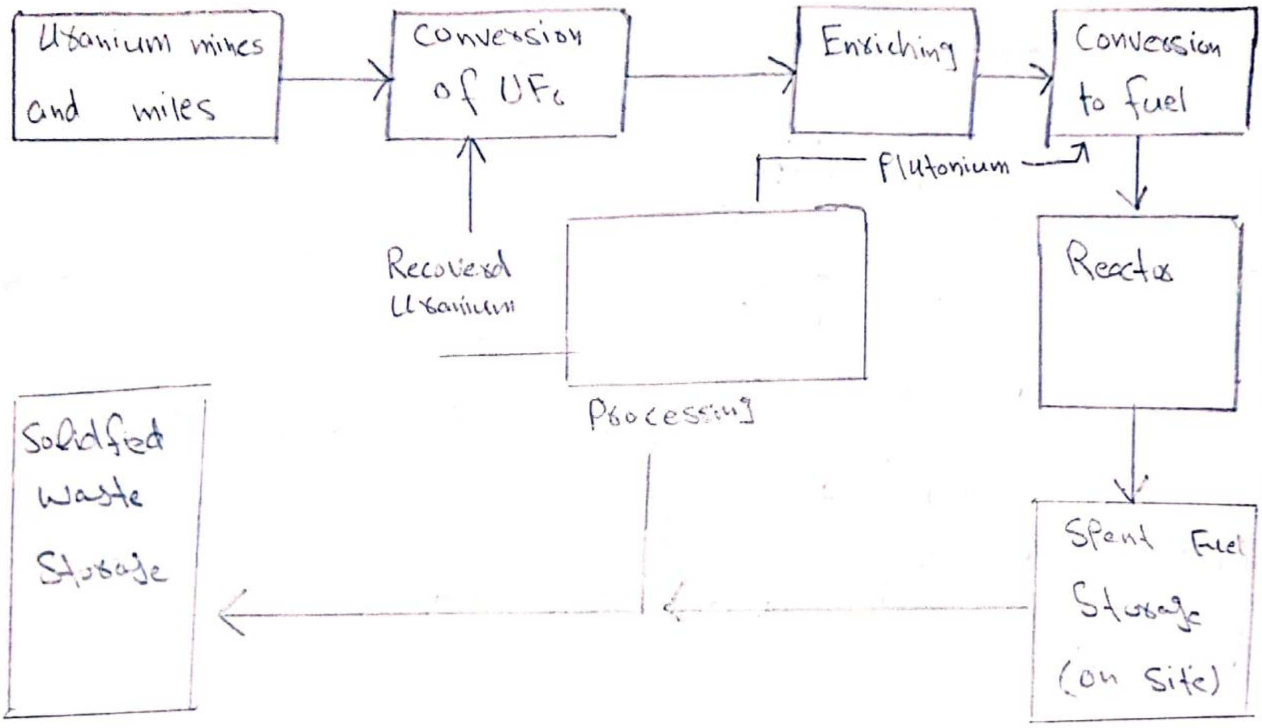
$$= 0.214 \text{ m}$$

$$dJ = 21.4 \text{ m}$$

Q3:- Explain diffrent stages of Nuclear Fuel Cycle

Ans:-

Nuclear Fuel Cycle



1) Mining and Miling:-

Uranium is usally mined be either surface or underground mining techniques depending on the depth at which the ore body is found.
From these the mined uranium ore is sed to a mail which is usually located close to the mine

At the mile the ore is Crushed and Ground to a fine Slurry Which is leached in Sulfuric acid to allow the Sepration of Uranium from the Waste rock It is then recoverd from Solution as Uranium oxide (U_3O_8) Concentrate

ii) Conversion of UF_6:

Because the Uranium need 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 the 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 U235

Hexafluoride Gas Can be Seprated into two Stream

Low Velocity U-238

High Velocity U-235

Centrifuged Method:

Gas Spun in Centrifuge
Lighter U-235 will seprate 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 stell, to form fuel rood.

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

Reactor Core:

The reactor core consist of fuel roods and control rods.
Fuel rods contained enriched uranium
Control rood are inserted b/w the fuel rods to absorb neutrons and slow the chain reaction