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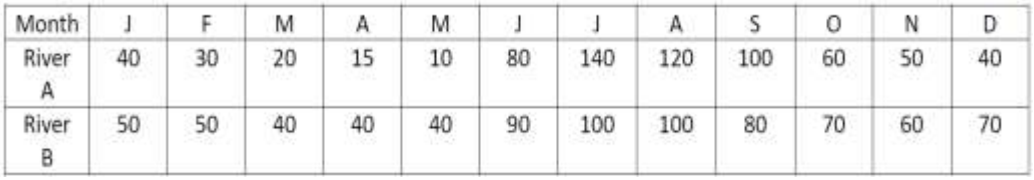
Internal Assesment Test – 2

Sub: ENERGY ENGINEERING				Code: 18ME81
Date: 15/04/2023	Duration: 90 mins	Max Marks: 50	Sem: 8	Branch (sections): ME (A,B)

Answer all FOUR questions.

		Marks	OBE	
			CO	RBT
1	State the important factors to be considered while selecting the site for hydro-electric power plant.	[10]	CO2	L2
2	With a neat sketch, explain the Rankine cycle OTEC plant.	[10]	CO2	L2
3	Explain Hydrograph, Flow duration curve, Surge tank, Run-off, Mass curve, water hammer effect.	[10]	CO2	L2

4 The run – off data of 2 rivers for 12 months is tabulated below. Run - off is given in millions of m^3/month. [20] CO2 L3



Month	J	F	M	A	M	J	J	A	S	O	N	D
River A	40	30	20	15	10	80	140	120	100	60	50	40
River B	50	50	40	40	40	90	100	100	80	70	60	70

Using the above date, find

i. Ratio of run – off of two rivers, if run – off is constant for 40% time of the year.

ii. If constant run – off is 80 % time of total year, then which river site is more preferable for run – off plant why?

iii. Which site is more preferable for storage type plant and why?

iv. At what percentage of time, run – off rate of both rivers is same?

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1.
The following factors must be considered while on site selection for hydroelectric power plant.

- Water availability
- Water storage
- Water head
- Accessibility of the site
- Distance from load centre
- Environment Aspects

Water Availability

The most important aspect for a hydel power plant is the water availability at the site because all designs are based on it. Therefore the run-off data for the proposed site should be available. It may not be possible to have run-off data but data as rainfall over the catchment area is always available.

From the data available, estimate should be made about, average quantity of water available, minimum and maximum quantity of water available throughout the year can be determined. The details of availability of water is necessary:

- To setup peak load plants such as steam, diesel and gas turbine plant.
- To decide the capacity of hydel electric plant.
- To provide spillways (or) gate relief during flood period.

Water storage

There is a wide variation in rainfall over the year, so it is required to store water for continuous generation of power. By using mass curve, the storage capacity can be calculated. The expenditure on the project depends upon maximum storage.

There are two types of storages.

- The storage is constructed to provide water for one year. In this case storage is full at the begin of the year and becomes empty by the end of year. So there is no shortage of water through out the year.
- The storage is constructed to provide water in sufficient quantity even during the worst dry periods.

Water head

The available water head depends upon the topological conditions. To generate required quantity of power, it is necessary to provide large quantity of water at a sufficient head. An increase in head, for a given output reduces the quantity of water to be supplied to the turbines. Hence water is supplied to the turbine at high potential.

Accessibility of the site

The Site Selection for Hydroelectric Power Plant should be easily accessible in order to use the electrical power generated. Because once the electricity is produced it must be delivered where it is needed (homes, schools, office) etc., and power must be transmitted over some distance to its users near the plant site. The site should have transportation facilities of rail and road.

Distance from load centre

It is a supreme importance that the power plant must be setup near the load centre. If distance between the load centre is less from power plant, then cost of erection is reduced and maintenance of transmission line will be easier.

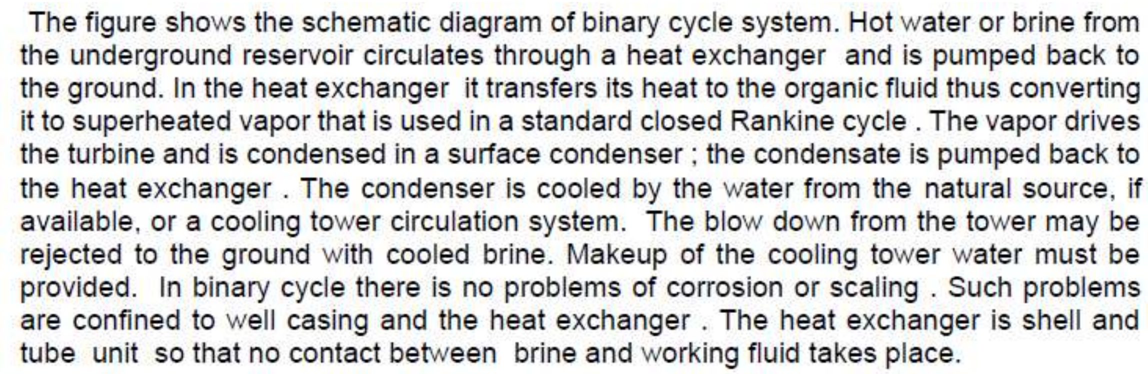
Environment Aspects

The land selected should be efficient and economical for the purpose of selection. The projects should be designed on the basic of best available information to enhance the local environment, and be in the best public interest.

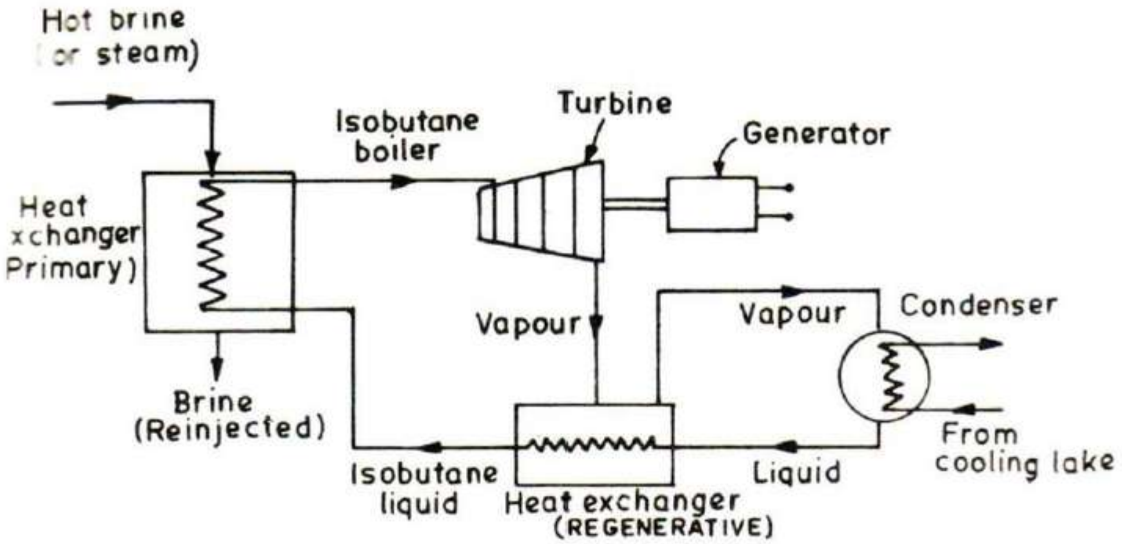
The Site Selection for Hydroelectric Power Plant should fulfill the following requirements.

- To assure safe, productive, healthy and culturally pleasing environment.
- To preserve important cultural, historic and natural aspects of site.
- To avoid health hazards and unintended consequences.
- The land selected for the site should be cheap and rocky.

2. RANKINE OTEC



The figure shows the schematic diagram of binary cycle system. Hot water or brine from the underground reservoir circulates through a heat exchanger and is pumped back to the ground. In the heat exchanger it transfers its heat to the organic fluid thus converting it to superheated vapor that is used in a standard closed Rankine cycle . The vapor drives the turbine and is condensed in a surface condenser ; the condensate is pumped back to the heat exchanger . The condenser is cooled by the water from the natural source, if available, or a cooling tower circulation system. The blow down from the tower may be rejected to the ground with cooled brine. Makeup of the cooling tower water must be provided. In binary cycle there is no problems of corrosion or scaling . Such problems are confined to well casing and the heat exchanger . The heat exchanger is shell and tube unit so that no contact between brine and working fluid takes place.



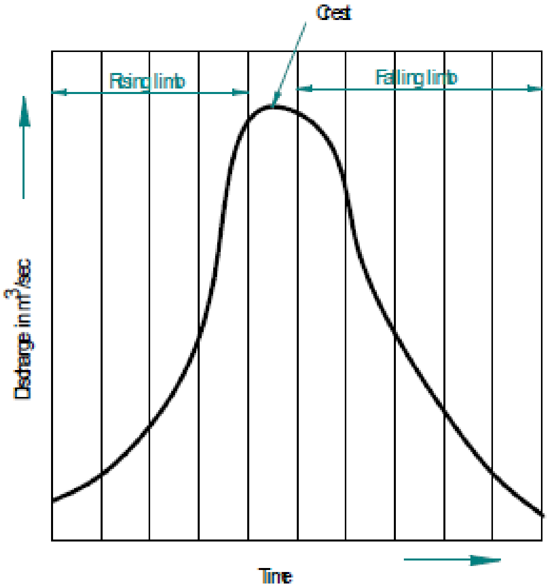
3.

HYDRO GRAPH

"Hydro graph is plot of discharge through a river versus time for specified period."

The time period for discharge hydrograph may be day, week, or month. Each hydro graph has a reference to a particular site. Besides the variation in flow indicated by a hydrograph , it also indicates the power available from the stream at different times of the day, week, month or year. Extreme conditions of flow can also be studied from hydro graph. Behavior of flash stream on a hydrograph is indicated by the steep rise and fall of the curve. A hydro graph also helps in the studies of the effect of storage on flow.

Flow duration curve



A flow duration curve is another useful form to represent the run off data for the given time. This curve is plotted between flow available during a period versus the fraction of time. The flow may be expressed in the form cubic meters per second per week or any other convenient unit of time knowing the available head of water , total energy of flow can be computed. By changing the ordinate to power instead of discharge , the power duration curve is obtained and the area under the curve would then represent the average yield of power from hydro power project. Thus by flow duration curve it is possible to know the total power available at the site .

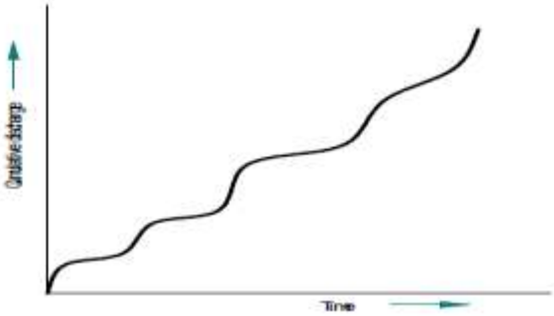
MASS CURVE:

The mass curve is a plot of cumulative volume of water that can be stored from stream flow versus time in days, weeks, or months. The unit used for indicating the storage are the cubic meters or the day second meters. Mass curve is an integral curve of the hydrograph which expresses the area under the hydrograph from one time to another time. Mathematically the flow mass curve is expressed as

$t2$

$\underset{t1}{V} = + Qt\ ,\ dt$

Where V is the volume of run off and Qt is the discharge in m3/s as a function of time.
A typical mass curve is a shown in figure below. The slope of the curve at any point indicates the rate of flow at that particular of time. If the curve is horizontal flow is zero and if there is a high rate of flow the curve rises steeply. Relatively dry periods are indicated as concave depressions on the mass curve.



Water hammer

Water hammer is defined as the change in pressure rapidly above or below normal pressure caused by sudden changes in the rate of water flow through the pipe according to the demand of prime mover. When the gates supplying the water to the turbines are suddenly closed owing to the action of governor , when the load on the generator is suddenly reduced, there is sudden rise in pressure in the upstream of the pipe supplying the water to the turbine. This sudden change of pressure and its fluctuations in the pipe line during reduction of load on the turbine is known as water hammer. The turbine gates suddenly opens because turbine needs more water due to increased demand on the generator and therefore, during increased load conditions , water has to rush through the pipe and there is tendency to cause a vacuum in the pipe supplying the water.
The pipe supplying the water must have the capacity with stand variations in the water pressures. The water hammer can occurs at all points in the penstock between the forebay or surge tank and the turbines.

Surge tank

Surge tank is open reservoir or tank in which the water level rises or falls to reduce the pressure swings so that they are not transmitted in full to a closed circuit. Important functions of the surge tank are

1) It reduces the distances between the free water surface and turbine thereby reducing the water hammer effect of the penstock and also protect the up stream tunnel from high pressure rises.
2) It serves as the supply tank to the turbine when the water in the pipe is accelerating during increased load conditions as a storage tank when the water is decelerating during the reduced load conditions.
3) It acts as relief valve when ever there is variations in water pressure in the penstocks.

Surge tank should be located as near to the power house as is feasible to reduce the length of the penstock thereby reducing water hammer effect. It is generally located at the junction of tunnel and penstock in order reduce its height.

4.

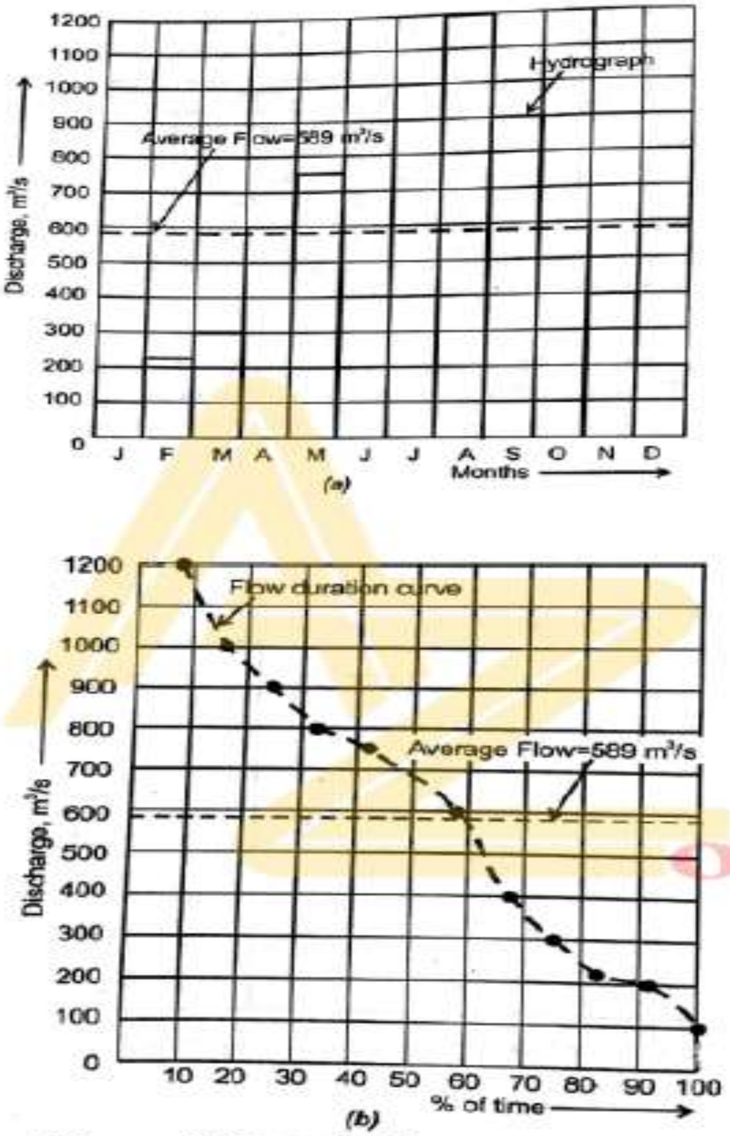


Fig. . **Hydrograph & flow duration curve**

Month	Discharge,m^3/s	Month	Discharge,m^3/s
January	100	July	1000
February	225	August	1200
March	300	September	900
April	600	October	600
May	750	November	400
June	800	December	200

From the given monthly flow data, the hydrograph is drawn as shown in **Fig. a**. Total flow is 7075 m^3/s, and the average flow is 589.6 m^3/s. To draw the flow duration curve, we have to compute the maximum periods for which each of the discharges are available, and the % of time for each flow. This is done as shown in the table below. In the table, column (a) lists the given discharge rates, column (b) gives the maximum length of time of the discharge availability, and column (c) computes the % of time of availability.

Discharge, m^3/s (a)	*Length of time, months (b)*	*(c) % of time =b/12* x 100
100	**12**	**100**
200	**11**	**91.7**
225	**10**	**83.33**
300	**9**	**75**
400	**8**	**66.7**
600	**7**	**58.3**
750	**5**	**41.7**
800	**4**	**33.3**
900	**3**	**25**
1000	**2**	**16.7**
1200	**1**	**8.3**

Using this computed data of % of time against the discharge, the flow duration curve is Plotted (the thick dotted curve) as shown in **Fig. b**.