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Unit-II

Load Curve :-

Power is needed for a variety of purposes such as domestic, commercial, industrial, municipal, agricultural and public transport. The unit of electrical energy for consumption is kilowatt-hour. In a common language, 1kwh (one kWh) is called a unit.

Thus,
In a Power system, a load curve or a load profile is a chart illustrating the variation in demand/ electrical load over a specific time.

Generation Companies use this information to plan how much Power they will need to generate at any given time.

At a certain hour of the day, the demand may reach the highest value, termed as the Peak load.
The max. demand on the station determines the size of the plant and its cost

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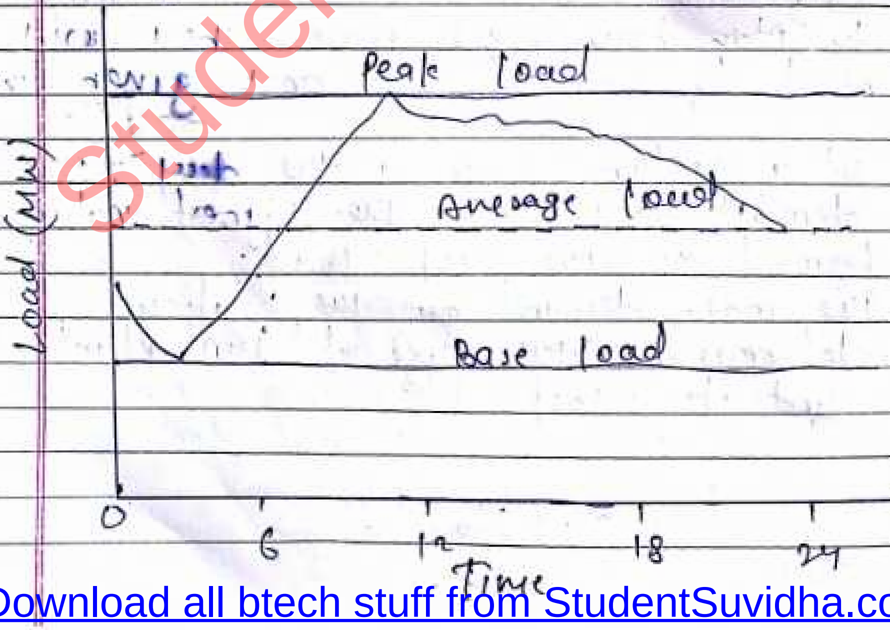
If a curve is drawn b/w load as the ordinate and time in hours as the abscissa for one day, then this curve is called a daily load curve.
Curves could be drawn for different time periods as a day, a week, a month or a year depending upon the requirement of load analysis.
Thus,
A load curve is a graph of the total load consumption with respect to the time, to connect to the supplying power system.



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Some Important terms

① Total Installed Capacity of the plant :-

The total capacity in kilowatts or million kilowatts of all the turbine generator units installed in a power house is called its installed capacity.

② Load Factor :-

Load factor is defined as the ratio of the average to the peak load during the same period.
Depending upon the period chosen, we may have diff. load factors such as daily, monthly or annual load factor.

$$\text{Load factor} = \frac{\text{Average load}}{\text{Peak load}}$$

$$\text{Annual load factor} = \frac{\text{Total yearly electrical units (kWh) produced}}{(\text{max. power demand in kW}) \times 365 \times 24}$$

③ Capacity factor OR Plant factor :-

Also called the plant use factor or plant factor.
It may be defined as the ratio of the average output of the plant for a given period of the time to the plant capacity.

utilization factor & plant use factor also called

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Capacity factor =

~~Average load over a given period~~

$$\frac{\text{Average load over a given period of time}}{\text{plant capacity}}$$

For Ex- if a plant with a capacity of 10,000 kW were to produce 40,000 kWh when operating for 100 hours. then

$$\text{capacity factor} = \frac{\frac{40,000}{100}}{10,000} = \frac{400}{10,000} \times 100 = 0.40 \text{ or } 40\%$$

(d) utilization factor :- It is defined as -

utilization factor (U.F.) =

$$\frac{\text{water actually utilized for power production}}{\text{water available in the river.}}$$

If the water head is assumed to be constant then the utilization factor would be equivalent to-

$$U.F. = \frac{\text{Max. power utilized}}{\text{Max. power available.}}$$

The value of U.F. usually varies from 0.4 to 0.9 for a hydel plant, depending upon the plant capacity, load factor and storage.

Diversity factor: = Sum of individual max. demands / Simultaneous max. demand

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(5) Firm Power :- (Primary Power) :-

The net amount of Power which is continuously available from a plant without any break on firm is known as firm Power

OR

Firm Power is the Power that is always available from the stream, even at times of lowest flow and lowest head.

Primary Power is on the ~~guran~~ guarantee basis

(6) Secondry Power :-

The excess Power available over the firm Power during the off peak hours or during monsoon etc is known as secondry Power.

There is no guarantee for the secondry Power

① ... ... powers involved in LDC

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Load duration Curve :-

A Load Duration curve (LDC) is used in hydro-electric power plants to illustrate the relationship b/w generating capacity requirements and capacity utilization.

A Load Duration curve is similar to load curve but the demand data is ordered in descending order of magnitude.

These are some facts about the LDC and can be summarised as -

* The LDC is an arrangement of all load levels in a descending order of magnitude.
* The area under the LDC represents the energy demanded by the system.
* It can be used in economic dispatching, system planning and reliability evaluation.
* It is more convenient to deal with it than the load curve

Thus,
this is a curve of load ve vs percentage of time.
It is usually plotted for a long duration such as a year.

Area under load Duration Curve = Total energy production during the Period.

Thus,
Annual load ~~curv~~ factor =

$$\frac{\text{Area under curve}}{\text{Area of rectangle corresponding to max. demand during the year}}$$

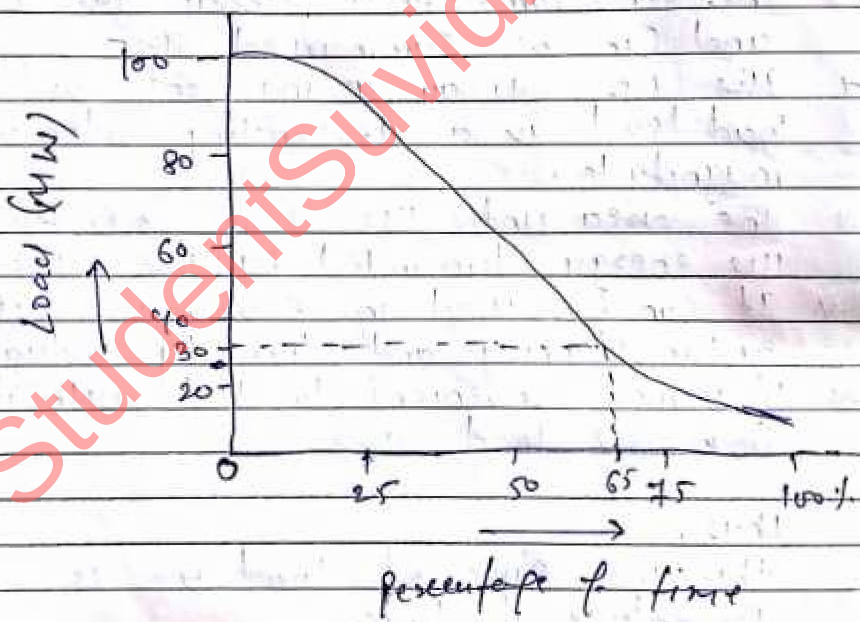

Fig - Load Duration Curve

Numerical — 20 marks

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The load on a hydel plant varies from a minimum of 10,000 kW to a max. of 35,000 kW. Two turbo-generators of capacities 22,000 kW each have been installed.
Calculate –

a) Total Installed capacity of the plant
b) plant factor.
c) Maximum demand
d) Load factor
e) utilization factor.

Sol^n :-

a) Total installed capacity of the plant –

Since two generators, each of capacity 22,000 kW are installed, we have

the total installed capacity = 2 × 22,000 kW = 44,000 kW Ans

b) Plant factor (Capacity factor) –
from eq^n –
Plant factor =

$$\frac{\text{Energy actually produced in time } t}{\text{Max. energy that can be produced in time } t}$$

⇒ Average load = 10,000 + 35,000 ... 22,500 kW

peek load = 35,000 kW.

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$$= \frac{\left(\frac{10,000 + 35,000}{2}\right) \times t}{44,000 \times t} = \frac{22,500}{44,000}$$

$= 0.511$

i.e. 51.1% Ans

c) Maximum Demand —

Maximum demand = 35,000 kW (as given) Ans

d) Load factor —

$$\frac{\text{Average load over a certain period}}{\text{Peak load during that period}}$$

$$= \frac{\frac{10,000 + 35,000}{2} \text{ kW}}{35,000 \text{ kW}} = \frac{22,500 \text{ kW}}{35,000 \text{ kW}}$$

$= 0.643$ i.e. 64.3% Ans

e) Utilization factor (U.F) —

$$\frac{\text{Max. Power utilized}}{\text{Max. Power available}}$$

$$= \frac{35,000 \text{ kW}}{44,000 \text{ kW}} = 0.795$$ i.e. 79.5% Ans

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Que Estimate installed capacity and magnitude of pondage for a run-of river hydel plant with the following data—

Daily flow in the river = 24 cumec.
Net head on plant = 12 m.
Efficiency of plant = 75%.

Solⁿ:
a).
Average inflow to the plant = $\frac{24 \times 7}{6}$ = 28 cumec.
= 28 cumec
Installed capacity of the plant is given by eqⁿ—
Installed capacity = 13.33 Q H. η
= 13.33 × 28 × 12 × $\frac{75}{100}$
= 3359 HP.
Pondage to store one day (idle day) flow
24 × 3600 × 24
= 2.07 × 10⁶ m³
or 2 million cubic metres.

Q. The fall at a canal regulator is 10 m. and the discharge available through turbines is 60 cumec. If the overall efficiency of the turbine is 80%. find the available power potential ?

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Sol^n: Using eq^n —

$13.33\, Q H \eta_o$

Available power = $13.33 \times 60 \times 10 \times \frac{80}{100}$

= 6398 HP.

Using eq^n —

$9.8\, Q H \eta_o$ (kW)

Available Power —

$9.8 \times 60 \times 10 \times \frac{80}{100}$ = 4704 kW