SUBJECT: POWER SYSTEM OPERATION AND CONTROL

SUBJECT CODE: EE 403

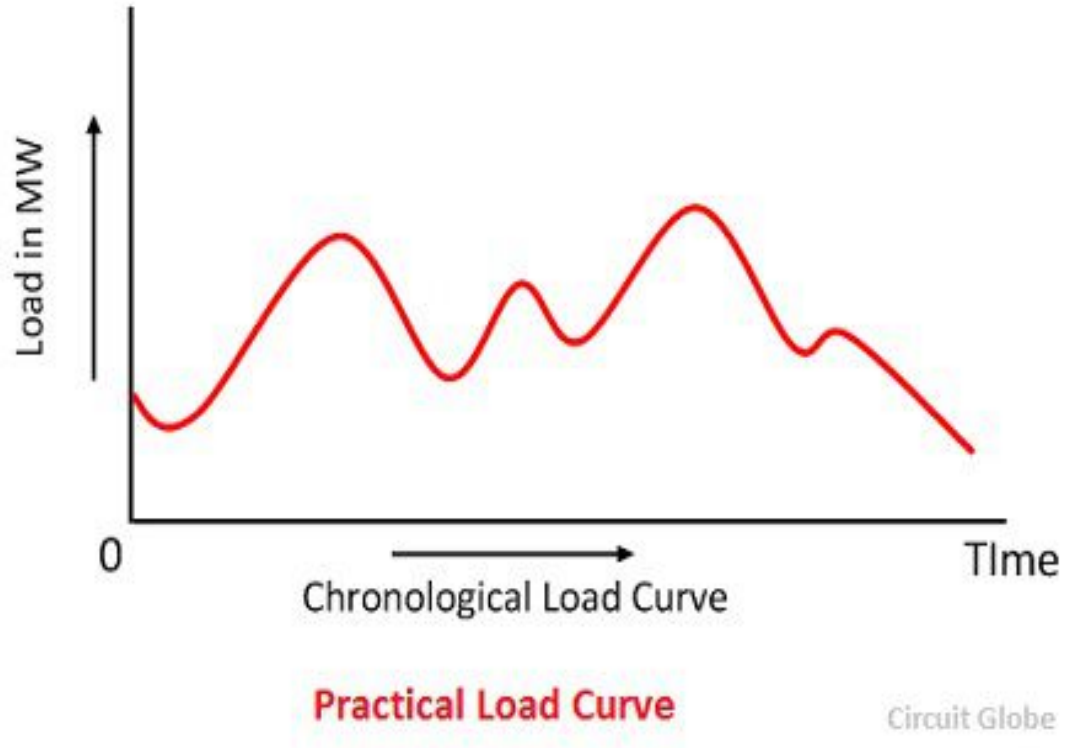
SEMESTER: VII

Module-II

- Load Curve
- Load Factor
- Load Duration Curve
- Diversity Factor
- Capacity Factor
- Electric Grid

LOAD CURVE

Load curve or chronological curve is the graphical representation of load (in kW or MW) in proper time sequence and the time in hours.

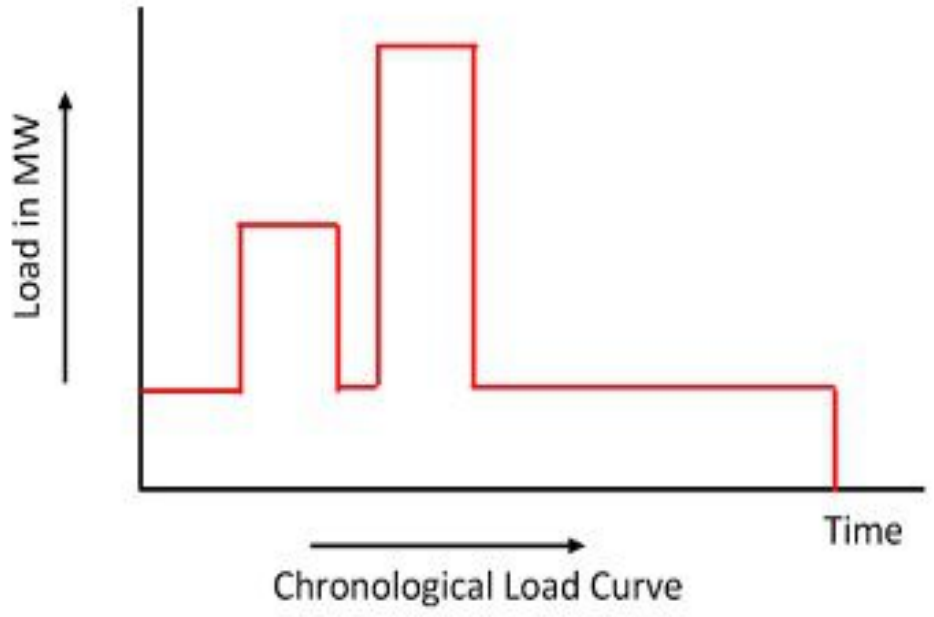


Information Obtained From Load Curve

- Load duration curve determines the load variation during different hours of the day.
- It indicates the peak load which determines the maximum demand on the power station.
- The area under the load curve gives the total energy generated in the period under consideration.
- The area under the curve divided by the total numbers of hours gives the load.
- The ratio of the area under the load curve of the total area of the rectangle in which it is contained gives the load factor.

Ideal Load Curve

The ideal load curve is flat, but practically it is far from flat. For a flat load curve, the load factor will be higher. Higher load factor means the more uniform load pattern with fewer variations in load.



Utility of Load Curve

- Load curve decides the installed capacity of a power station.
- It is helpful in choosing the most economical sizes of the various generating units.
- The load curve estimates the generating cost.
- It decides the operating schedules of the power station, i.e., the sequence in which the different generating units should run.

Load Factor

- Load factor is defined as the ratio of the average load over a given period to the maximum demand (peak load) occurring in that period.
- Load factor is the ratio of energy consumed in a given period of the times of hours to the peak load which has occurred during that particular period.

$$Load\ factor = \frac{average\ load}{peak\ load}$$

$$Load\ factor = \frac{average\ load \times T}{peak\ load \times T}$$

$$Daily\ load\ factor = \frac{Total\ kwh\ during\ 24\ h\ of\ the\ day}{(peak\ load\ in\ kW)\ \times 24\ h}$$

$$Annual\ load\ factor = \frac{total\ kWh\ during\ the\ year}{(peak\ load\ in\ kW) \times (8760\ hours)}$$

For calculating load factor, the following information is required;

- ✔ Actual kilowatt hours used (kWh)
- ✔ Peak kilowatt demand (kW)
- ✔ Number of days

FOR EXAMPLE

Let total kWh = 36,0000 kWh

Demand = 100kW

The number of days = 30 days

Hours per day = 24 hours

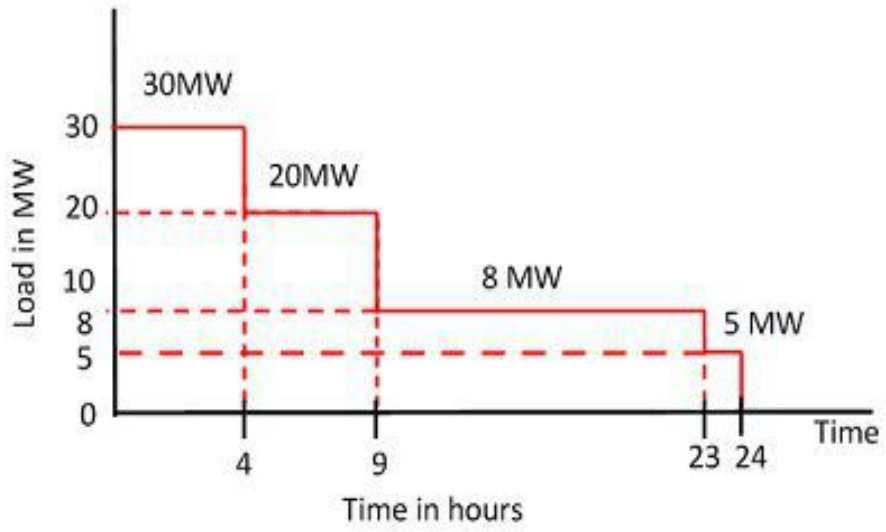
Solution

$$Monthly\ load\ factor = \frac{36000}{100 \times 30 \times 24} = 0.50$$

$$= 0.50 \times 100 = 50\%$$

Load Duration Curve

- The load duration curve is defined as the curve between the load and time in which the ordinates representing the load, plotted in the order of decreasing magnitude.



Load Duration Curve

$$Average\ Demand = \frac{kWh\ (or\ MWh) consumed\ in\ a\ given\ period\ of\ time}{hours\ in\ the\ time\ period}$$

$$Average\ Demand = \frac{area\ under\ the\ load\ duration\ curve}{base\ of\ the\ load\ duration\ curve}$$

Procedure for Plotting the Load Duration Curve

- ✔ From the data available from the load curve determines the maximum load and the duration for which it occurs.
- ✔ Now take the next load and the total time during which this and the previous load occurs.
- ✔ Plots the loads against the time during which it occurs

Example: Consider the daily load curve data of the power system.

Time	Load in MW
6.00 am to 8.00am	8
8.00 am to 1.00 noon	20
1.00 noon to 2.00 noon	5
12.30 noon to 6.00 pm	30
6.00 pm to 6.00 am	8

Solution: The data available from the load curve are tabulated as follows. Here the total time is 24 hours or 100%.

Load in MW	Hours in a day	Time in percentage
30	4	4/5×100=16.67%
20	4+5	9/24×100=37.5%
8	2+4+5+12 =23	23/24×100=95.83%
5	4+5+2+12+1 = 24	24/24×100=100%

Information Available Form Load Duration Curve

- ✔ The load duration curve gives the minimum load present throughout the specified period.
- ✔ It authorises the selection of base load and peak load power plants.
- ✔ Any point on the load duration curve represents the total duration in hours for the corresponding load and all loads of greater values.
- ✔ The area under the load duration curve represents the energy associated with the load duration curve.
- ✔ The average demand during some specified time periods such as a day or a month can be obtained from the load duration curve.

Diversity Factor

Diversity factor is defined as the ratio of the sum of the maximum demands of the various part of a system to the coincident maximum demand of the whole system.

$$Diversity\ factor = \frac{(sum\ of\ individual\ maximum\ demands)}{(coincident\ maximum\ demand\ of\ the\ whole\ system)}$$

$$F_D = \frac{D_1 + D_2 \ldots\ldots\ldots\ldots + D_n}{D_g}$$

OR

$$F_D = \frac{\sum_{i=1}^{n} D_i}{D_g}$$

F_D = Diversity factor

D_i = Maximum demand of the load I, irrespective of the time of occurrence.

D_g = D(1+2+3…….n) – maximum coincident demands of a group of n load.

Capacity Factor

- The capacity factor is defined as the ratio of the total actual energy produced or supply over a definite period, to the energy that would have been produced if the plant (generating unit) had operated continuously at the maximum rating.

$$Capacity\ factor = \frac{(actual\ energy\ produced\ or\ supplied\ in\ time\ T)}{maximum\ plant\ rating \times T}$$

$$Annual\ capacity\ factor = \frac{actual\ annual\ energy\ generation}{maximum\ plant\ rating\ \times 8760}$$

$$Capacity\ factor = \frac{peak\ load}{plant\ capacity} \times load\ factor$$