CHAPTER TWO

Generation and Distribution factors

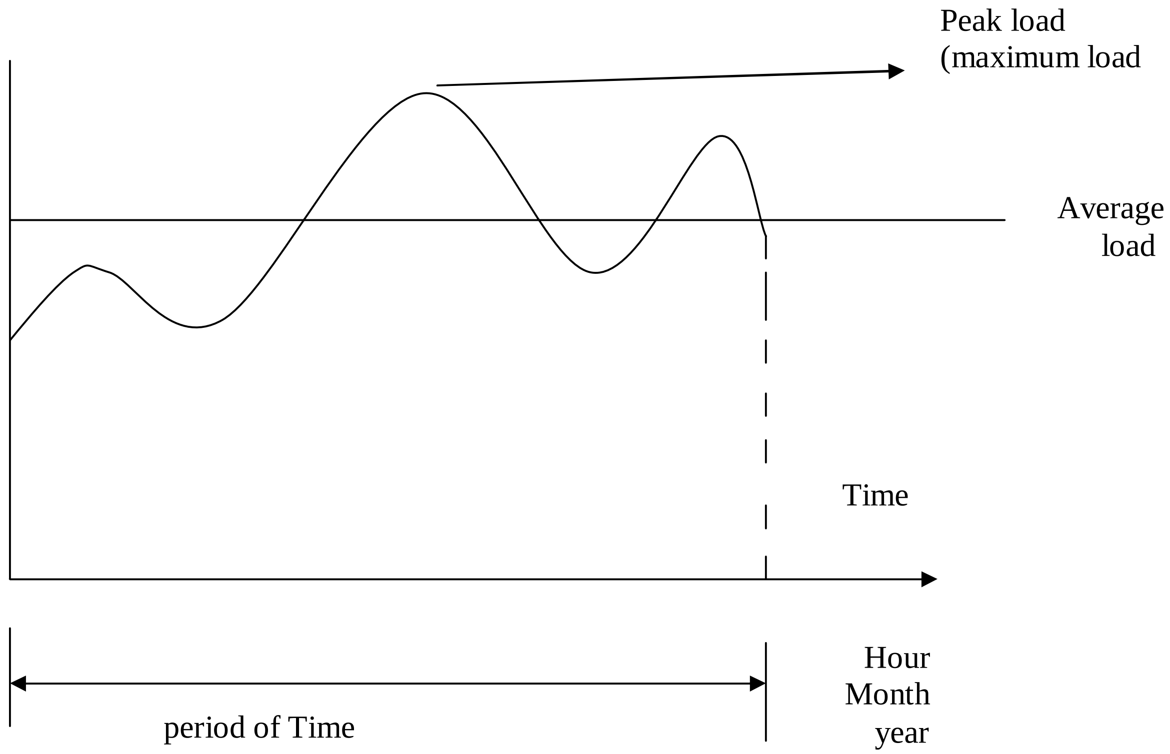


Fig. (1)
Load curve

*peak load (maximum load):.

The maximum power that consumed by the load during A specific given time and it is equal to the maximum actual power that generate by the plant . when neglecting the Transmission line losses.

Power Generation = power load + losses of lines

$$P_G = P_L[\text{when losses of lines} = 0]$$

*Average Load :.

It is the average power that consumed by the load during a certain period of time and it is equal to the actual power that generated by the plant during the same period of time when neglecting Transmission line losses.

*Load Factor :.

It is the ratio of the average load to the maximum load for a certain period of time .The period of time a day, the load factor is a daily load factor and if the period of time is month the load factor is monthly load factor and similarly for the yearly load factor.

$$\text{Load factor} = \frac{average\ Load}{MAX - Load}$$

***Load Curve:.**

Show the characteristics of the load over a certain period of time (day, month, year) . The curve is plotted by placing the ordinate (kw) with their proper time sequin as shown in the fig.(1)

***Installed Capacity (plant capacity) :.**

It is the maximum generation in KW or MW and it is depend on the design of machine (generator)

*__Plant Capacity Factor :.__

$$= \frac{\text{Actual energy produced in KW}}{\text{Maximum possible energy that could be produced (based on installed capacity)}}$$

$$= \frac{\text{Average load KW}}{\text{Installed Capacity KW}}$$

*__Plant use factor :__

$$= \frac{\text{Actual energy produced (kwh)}}{\text{(plant capacity)* (no.of hours that the plant has been in operation)}}$$

$$= \frac{\text{Average load} \times \text{time (24 hours if the time is a day)}}{\underset{kw}{\text{(Installed Capacity)}} \times \underset{h}{\text{(hours in operation)}}}$$

***Utilization Factor :.**

The utilization factor for a plant depend on the use to which the plant is put.
A LOW utilization factor means that the plant is either a stand by plant or has been installed to take into account the future increase in the load

$$\text{utilization factor} = \frac{\text{Maximum load}}{\text{Installed capacity}}$$

Diversity factor:.

The effect of the diversity factor is to reduce the simultaneous maximum demand on the station (which means reduce the capital cost of the station) for the same individual demand and consequently a lower overall rate for a generation station electric.

$$\text{Diversity factor} = \frac{\text{Sum of consumer max. demand in KW}}{\text{Max . load on the station KW}}$$

***Daily Load Curve :.**

Show the characteristics of the load over period of 24 hours (day)

*Load duration carve:

Represent the same data of load curve but the ordinate are arranged in magnitude sequence the greeted load at the left and the lesser load to the right and the least load at the end of the curve .

EX1) A generation station has a maximum demand of 20 MW, a load factor of 60 % , plant capacity factor of 48% and plant use factor of 80 % . find :

1-The daily energy produced

2-The reserve capacity

3-The maximum energy that could be produced daily if the plant were running all the time .

4-The maximum energy that could be produced daily if the plant were running according to operation schedule were fully loaded.

solution:

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

$$0.6 = \frac{\text{Average load}}{20\ \text{MW}}$$

Average load = 12 MW

= 12000 KW

$$\text{Plant capacity factor} = \frac{\text{Average load}}{\text{Installed capacity}}$$

$$0.48 = \frac{12\ \text{MW}}{\text{Installed capacity}}$$

$$\text{Installed capacity} = \frac{12}{0.48} = 25MW$$

(Plant capacity) Installed capacity = $25000kw$

1) The daily energy produced = average load $\times 24$

$= 12\ MW \times 24h$

$= 288\ Mwh$

$= 288\ 000\ Kwh$

2)The reserve capacity = Installed capacity –Max. load

$= 25\ MW - 20\ MW$

$= 5000\ KW$

3)The maximum energy daily when the plant running all the time (day 24 h)

= Installed capacity $\times 24\ h$

$= 25\ MW \times 24\ h$

$= 600\ Mwh$

$= 6000000\ KWh$

$$4)\text{Plant use factor} = \frac{\text{Actual energy produced } M\,Kwh}{\text{Plant capacity} \times (\text{no. of hours that the plant has been in operation})}$$

$$0.8 = \frac{\text{average load} \times 24\,h}{\text{The maximum energy that could be produced Daily it the plant were running according to is operation schedule (y)}}$$

$$0.8 = \frac{288000\ kwh}{y}$$

$$y = 360\ Mwh$$

Also

$360\ M\ wh =$ plant $\times\ no.of$ hours in operation

$360\ Mwh = 25000\ kw\ *\ h$

$h = 14.4$ The hours that the plant in operation

*The hours that the plant is off = $24 - 14.4 = 9.6h$

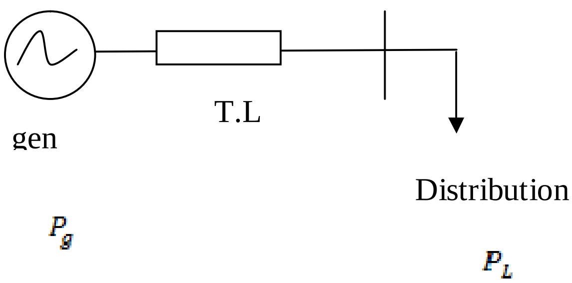
Ex 2) A generation station of $1MW$ supplied a region his demand B as follow :.

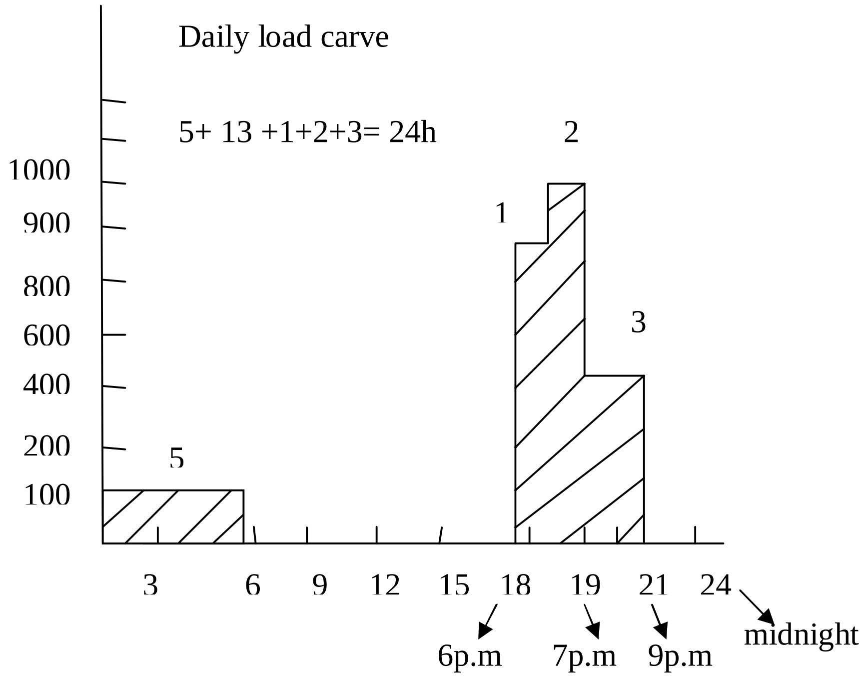
From midnight	To 5 a.m	$100\ kw$
From 5 a.m	To 6 p.m	No- load
From 6 a.m	*To 7 p.m*	$800kw$
From 7 p.m	*To 9 p.m*	$900kw$
From 9 p.m	*To midnight*	$400kw$

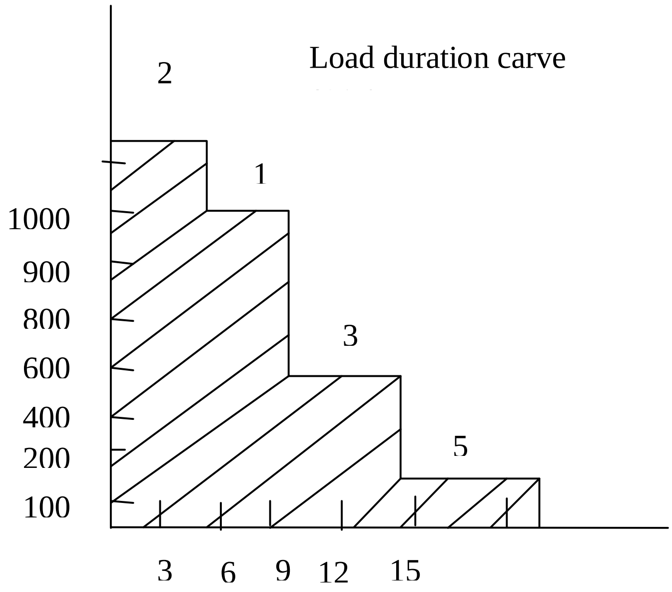
With neglect Transmission line losses
1-plote the daily load curve and the load duration curve
2-find the load factor , the reserve capacity , plant capacity factor, plant use factor , the hours that the plant has been off and utilization factor.

solution)
when the transmission line losses are neglected

$$p_g = p_L$$







Hours in operation = 11h } 24 h (day)
Hours in off = 13 h

Installed capacity = $1\ MW = 1000kw$

The energy that produced during 24h is

$$(s \times 100) + (13 \times 0) + (1 \times 800) + (2 \times 900) + (3 \times 400) = 4300kwh$$

The average load = $\frac{4300\ kwh}{24\ h} = 179.16$kw

The energy consumption during $24h = 4300\ kwh$

The load factor $\frac{average\ load}{Max.load} = \frac{179.16\ kw}{900\ kw} = 0.199$

= 0.19.19 %

The maximum load = $900\ kw$

2- The resolve capacity = 1000- 900

$= 100\ kw$

3- plant capacity factor =$\frac{average\ load}{Installed\ capacity} = \frac{179.16kw}{100\ kw} = 0.1791$

$= 1791\ \%$

4- plant use factor = $\frac{4300kwh}{1000\ kw \times 11\ h} = 0.3909$

= 39.09 %

Where plant use factor =$\frac{averge\ load \times 24}{plant\ capacty \times hours\ inoperation}$

Utilization factor = $\frac{Maximum\ load}{Installed\ Capacity} = \frac{900kw}{1000\ km} = 0.9$

$= 0.9$

90 % =

Ex3) An electric supply of $10MW$ supplied a demand of region A and B where the variation of the load is given by:

<u>Consumer A</u>

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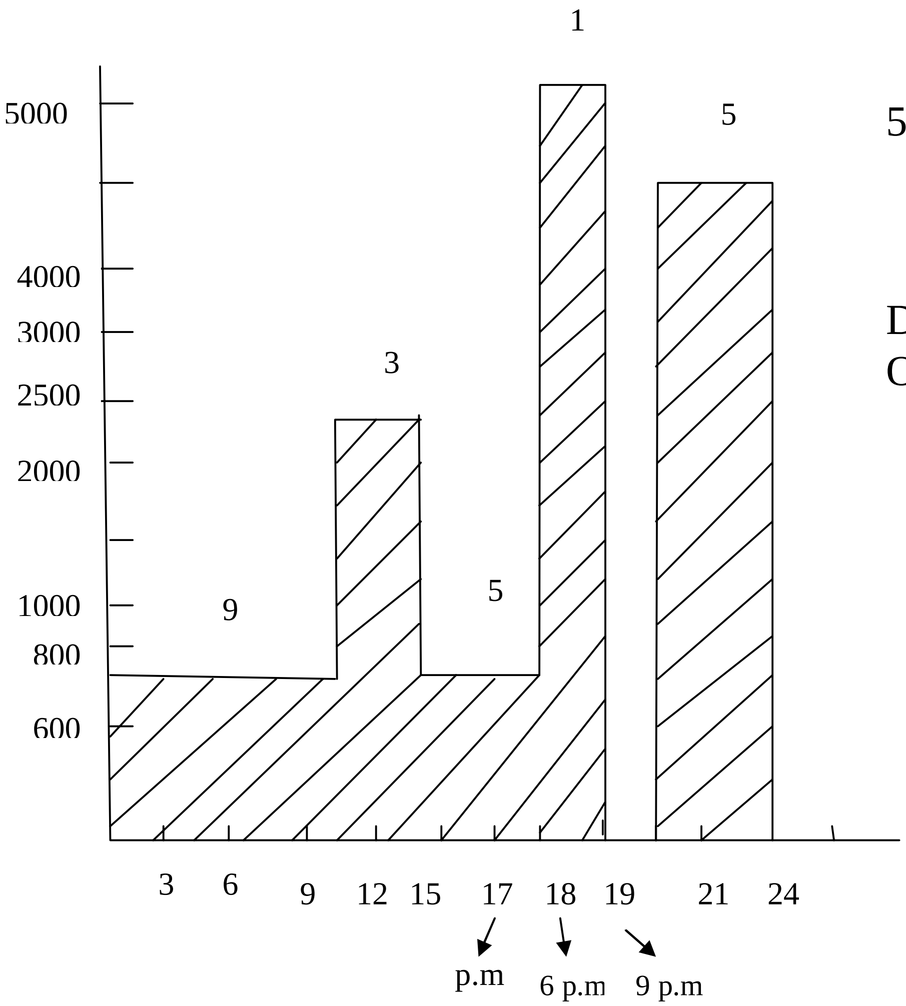
From midnight	To 9 a.m	600 kw
From 9 a.m	To 12 noon	2500 kw
From 12 a.m	To 5 p.m	800 kw
From 5 a.m	To 6 p.m	5000 kw
From 6 p.m	To 7 p.m	No – load
From 7 p.m	To midnight	4000 kw

<u>Consumer B</u>

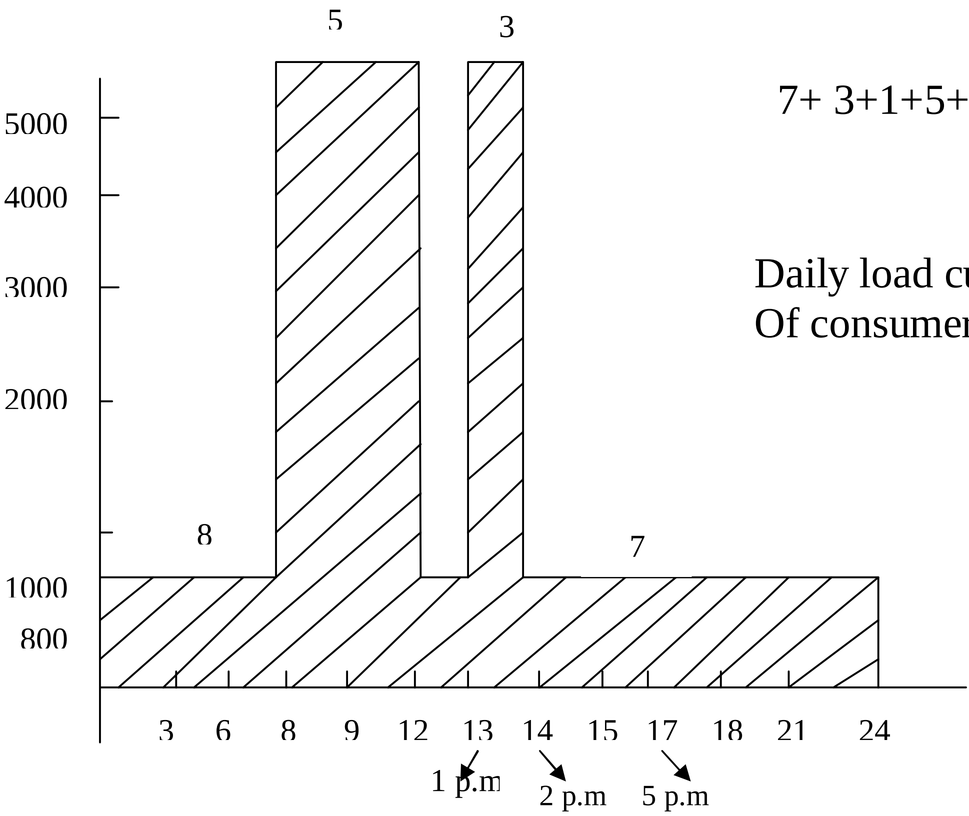
From midnight	To 8 a.m	800 kw
From 8 a.m	To 1 p.m	5000 kw
From 1 a.m	To 2 p.m	800 kw
From 2 p.m	To 5 p.m	5000 kw
From 5 p.m	To midnight	800 kw

-Find the load factor and the diversity factor of the Total system.



5+1+1+5+3+9+24 h

Daily load curve
Of consumer A



7+ 3+1+5+8=24 h

Daily load curve
Of consumer B

From midnight	To 8 a.m	(600+800)= 1400 kw
From 8 a.m	To 9 a.m	(600+5000) =5600 kw
From 9 a.m	To 12 noon	(2500+5000)= 7500kw
From 12 noon	To 13 (1 p.m)	(800+5000)=5800kw
From 13(1 p.m)	To 14 (2 p.m)	(800+800)=1600kw
From 14 (2 p.m)	To 17 (5 p.m)	(800+ 5000)= 5800kw
From 17(5 p.m)	To 18 (6 p.m)	(5000+800)=5800kw
From 18 (6 p.m)	To 19 (7 p.m)	(0+ 800)= 800kw
From 19 (7 p.m)	To 24 (might)	(4000+800)=4800kw

Due to the fig. of the total system A and B
The energy produced in 24 h is

$$= (8 + 1400) + (1 \times 5600) + (3 \times 7500) + (1 \times 5800) + (1 \times 1600)$$

$$+(4 \times 5800) + (1 \times 800) + (5 \times 4800) = 94700\ kwh$$

The average load $= \frac{94700}{24} = 3945 - 8\ kw$

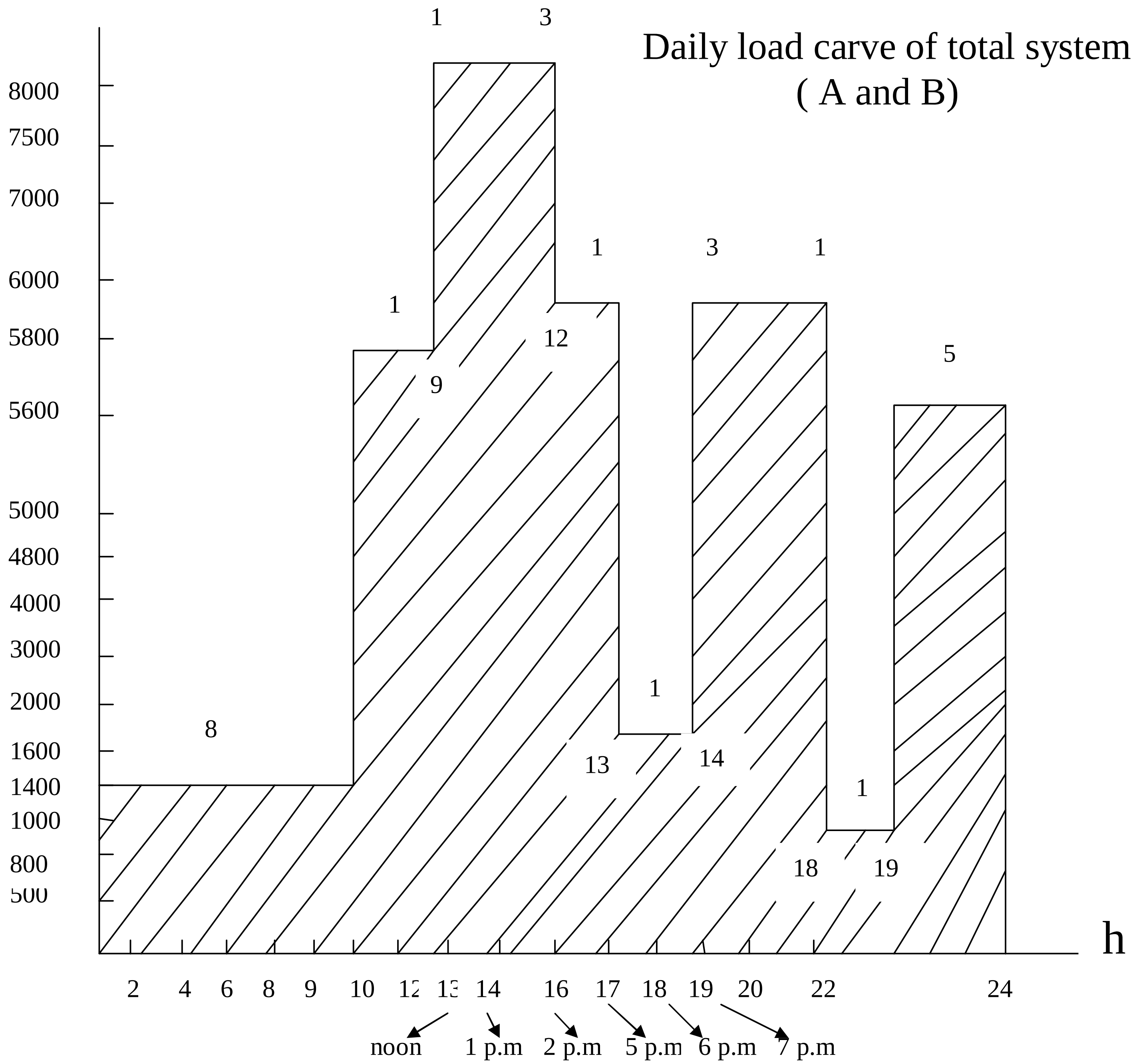
The load factor $= \frac{average\ load}{Max.load} = \frac{3945.8}{7500} = 0.526$

The reserve capacity = 10,000- 7500= 2500 kw

Plant capacity factor = $\frac{average\ load}{Installed\ capacity} = \frac{3945}{10000}$

$= 39.45\ \%$

5+1+1+3+1+1+3+1+8=24h



$$\text{Plant use factor} = \frac{average\ load \times 24}{plant\ capacity \times hours\ in\ opeation}$$

$$= \frac{94700}{10,000 \times 24} = 39.45\ \%$$

*If the plant capacity factor = plant use factor

- The plant is operalion in 24 h
- The hours that the plant is off is zero

The diversity factor = $\frac{sum\ of\ consumrs\ MAX\ .dermand}{\max .load\ on\ the\ station}$

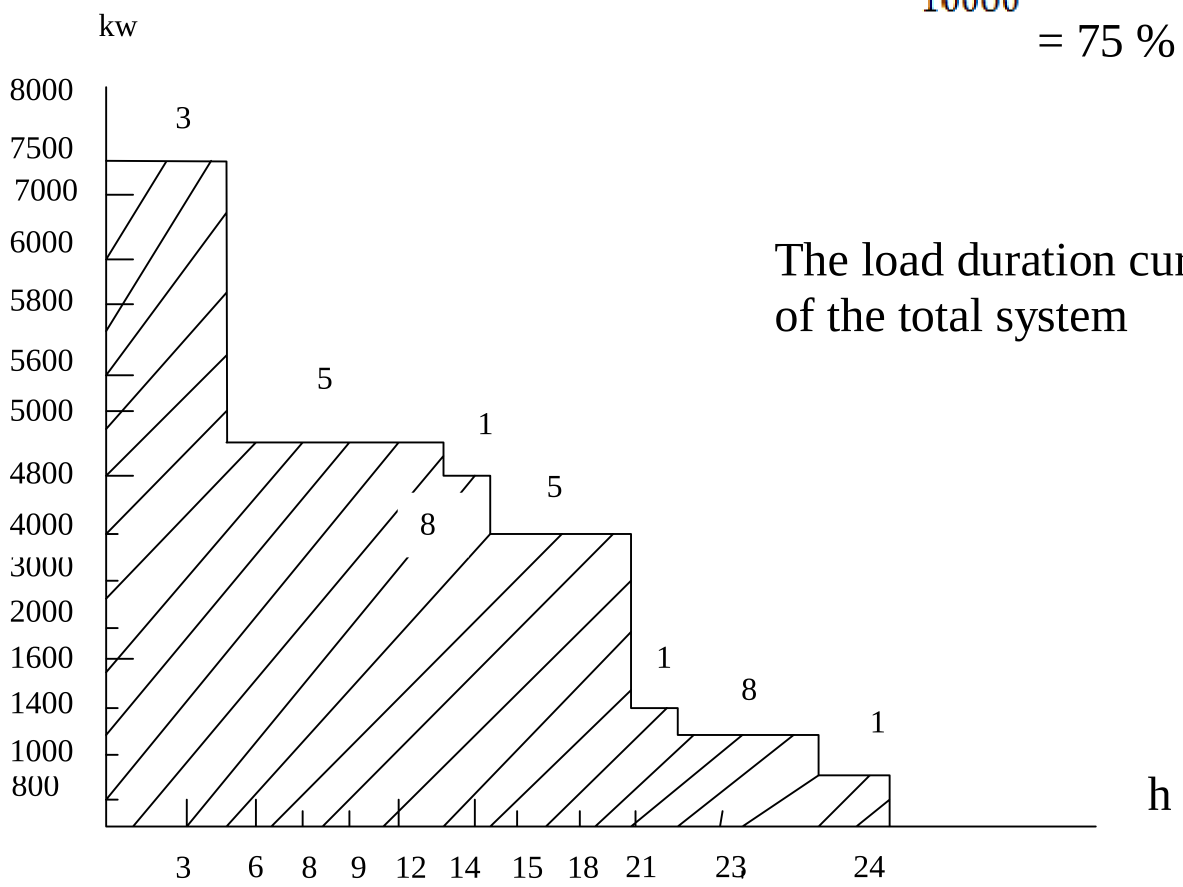
$$= \frac{5000 + 5000}{75000} = 1.333$$

The system is improve by increasing the load factor and increasing the diversity factor (due to the decreasing in the maximum load)

The utilization factor = $\frac{Max.load}{Installed\ capacity}$

$$= \frac{7500}{10000} = 75\ \%$$

= 75 %



The load duration curve of the total system