Power Systems-EE309

Assignment 1

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Question 1

Final Results:

(a) Daily energy produced= 900000000 W.
(b) No. of operating hours daily= 15 h.
(c) Reserve Capacity= 25000000 W.
(d) Max energy produced when the machine runs all the time= 1440000000 Wh

Theoretical Calculation:

(1). Max. demand = 50 MW.
load factor, LF = 75%.
PCF = 50%.
Plant use factor = 80%. = actual energy produced

$$LF = 0.75 = \frac{\text{Avg. load}}{\text{Max. demand}} = \frac{\text{Avg. load}}{50\,MW}$$

Avg. Load = 37.5 MW

$$PCF = 0.5 = \frac{37.5\,MW}{\text{Plant capacity}}$$

Plant capacity = 75 MW.

(a).
Observation Time = 24 hrs.

$$\text{Avg. load} = 37.5\,MW = \frac{\text{Total energy produced}}{24\,hrs}$$

$\boxed{\text{Total energy produced} = 37.5 \times 24\ MWh = 900\ MWh.}$

(b).
$$\text{Plant use factor} = \frac{\text{actual energy generated}}{(\text{plant cap.}) \times (\text{operation time})}$$

$$0.8 = \frac{(900\,MWh)}{(75\,MW) \times (\text{operation time})}$$

operation time = 15 hrs.

(c).
Reserve capacity = Plant capacity − Max. demand
= 75 MW − 50 MW.
= 25 MW.

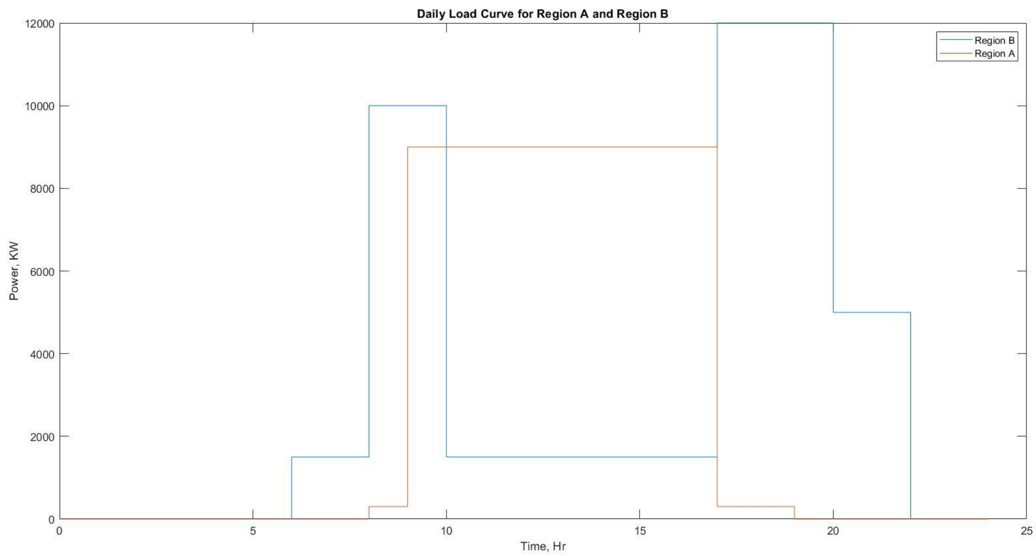
(d). Max. energy generated when runs all time = Power use factor × plant cap. × operation time
= 0.8 × 75 MW × 24 hrs.
= 1440 MWhr

Question 2:

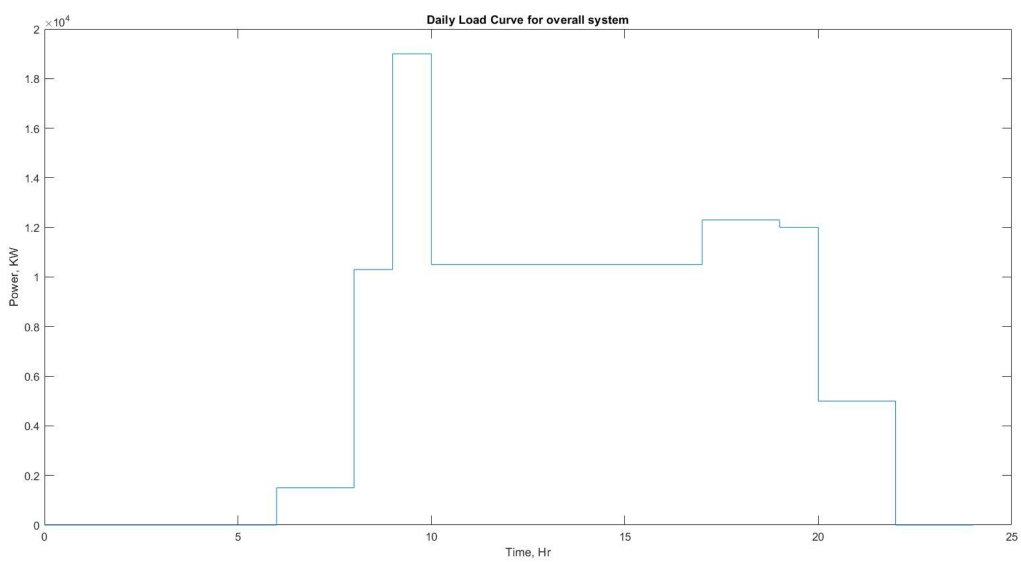
Final Results:

(a)

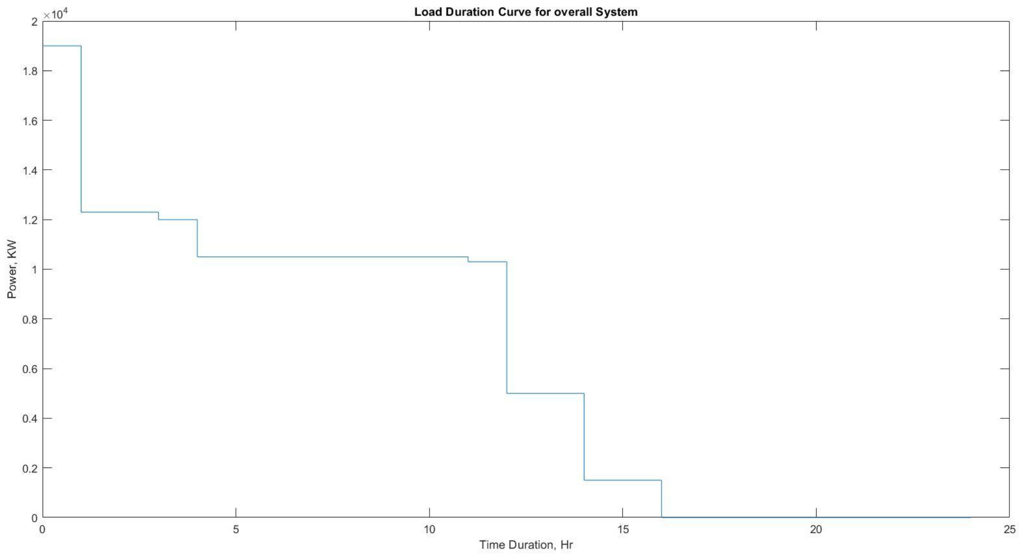
- DailyLoad Curve of Region A and Region B:



- Daily Load Curve of the overall system:



(b) Load Duration Curve of the overall system:



(c) Load Diversity Factor=1.105263e+00.
(d) Plant Utilization Factor=9.500000e-01.
(e) Plant Capacity Factor=3.175000e-01.
(f) Plant Use Factor=4.762500e-01.
(g) Region A is an industrial region since the load requirements are significantly high during the day and almost none during morning and evening hours whereas for region B the load requirements hit the peaks in morning and evening. So, Region B is Residential. There is a possibility that region A is the industry where people living in region B go and work.

Theoretical Calculation:

(2) (a) ✓

(b) ✓

(c) diversity factor (9-10) hrs $= \dfrac{9000 + 12000}{(9000+10000)}$

$= \dfrac{21000}{19000} = \dfrac{21}{19} =$

(e). Total energy generated = area under overall DLC

$= (1500 \times 2) + (10300 \times 1) + (19000 \times 1) + (10500 \times 7)$

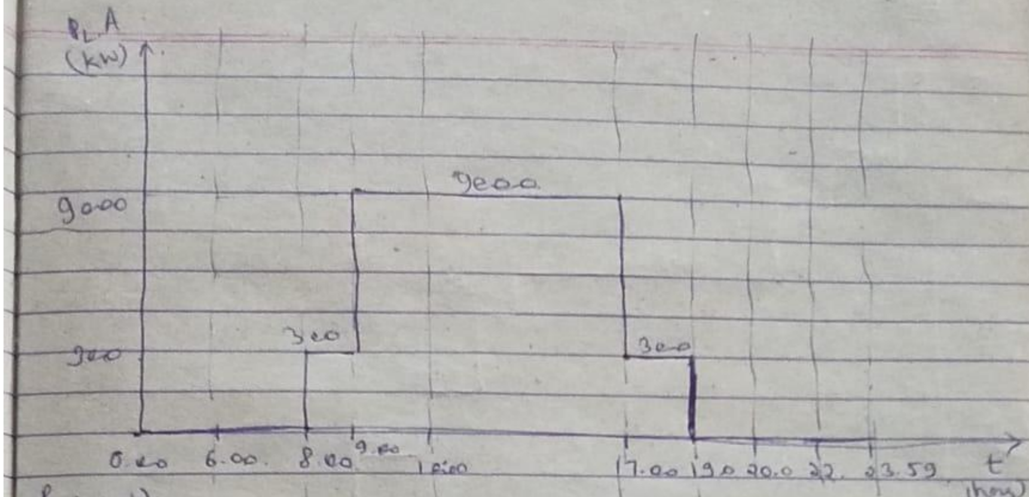
$(12300 \times 2) + (12000 \times 1) + (5000 \times 2)$

$= 152.4$ MWh

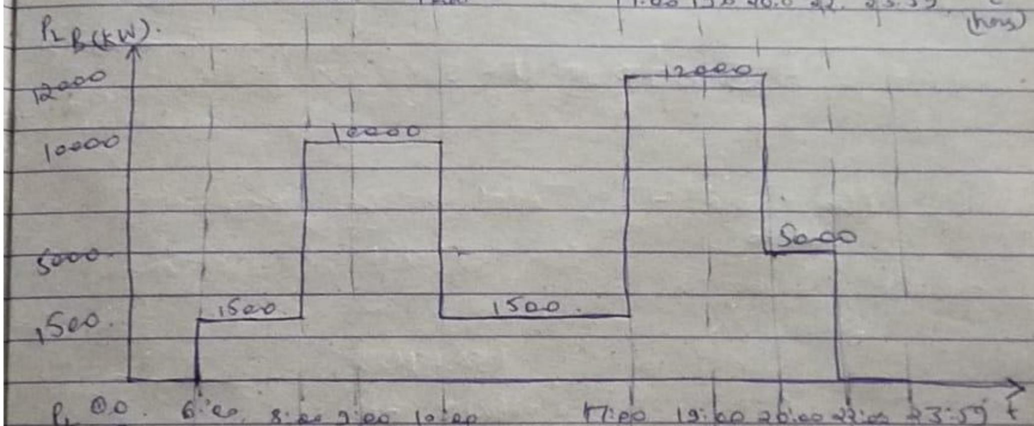
Plant capacity factor $= \dfrac{152.4 \text{ MWh}}{20 \text{MW} \times 24 \text{hr}}$

$= 0.3175$

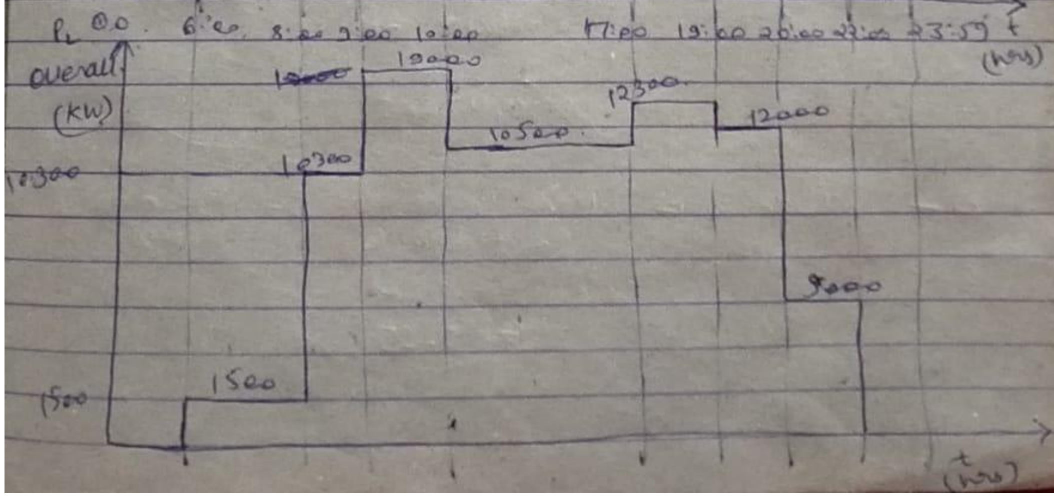
(a). DLC.



P_L A (kW)
9000
900
300
9000
300
0.00
6.00
8.00
9.00
10.00
17.00
19.0
20.0
22.
23.59
t (hrs)

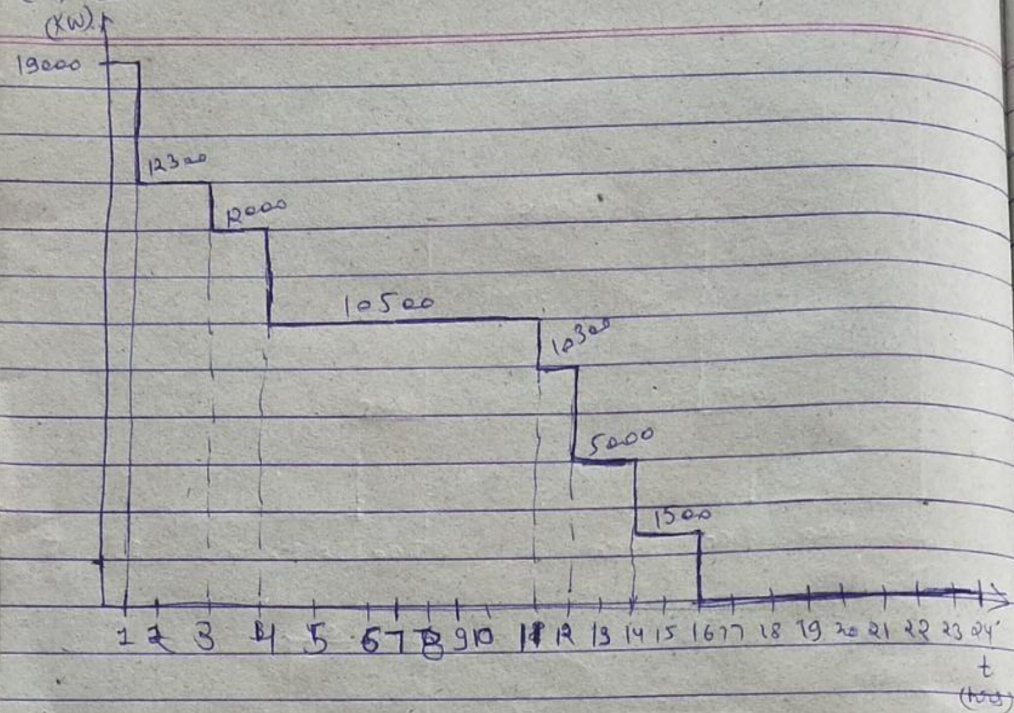


P_L B (kW)
12000
10000
5000
1500
1500
10000
1500
12000
5000
0.0
6.00
8.00
9.00
10.00
17.00
19.00
20.00
22.00
23:59
t (hrs)



P_L overall (kW)
10300
1500
1500
10300
19000
10500
12300
12000
9000
t (hrs)

(b) LDC of overall system.



(f) Plant use factor $= \dfrac{\text{Total energy generated}}{\text{Plant capacity} \times \text{Operation time}}$

$= \dfrac{152.4\,MWh}{20\,MW \times 16\,hr}$

$= 0.47625$

(d) = Utilization factor $= \dfrac{\text{Maximum demand}}{\text{Plant capacity}} = \dfrac{19000\,kW}{20\,MW}$

$= 0.95$

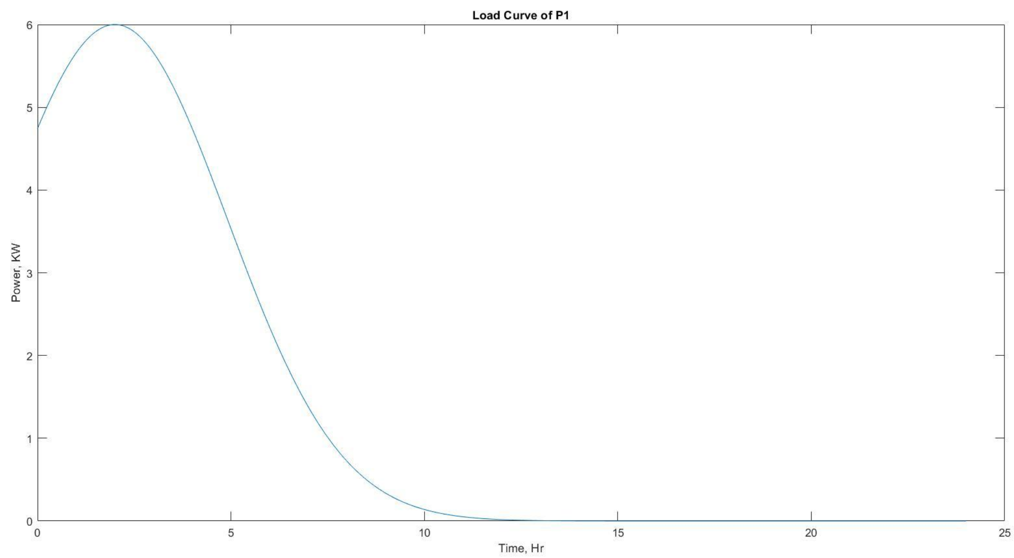
Question 3:

Final Results:

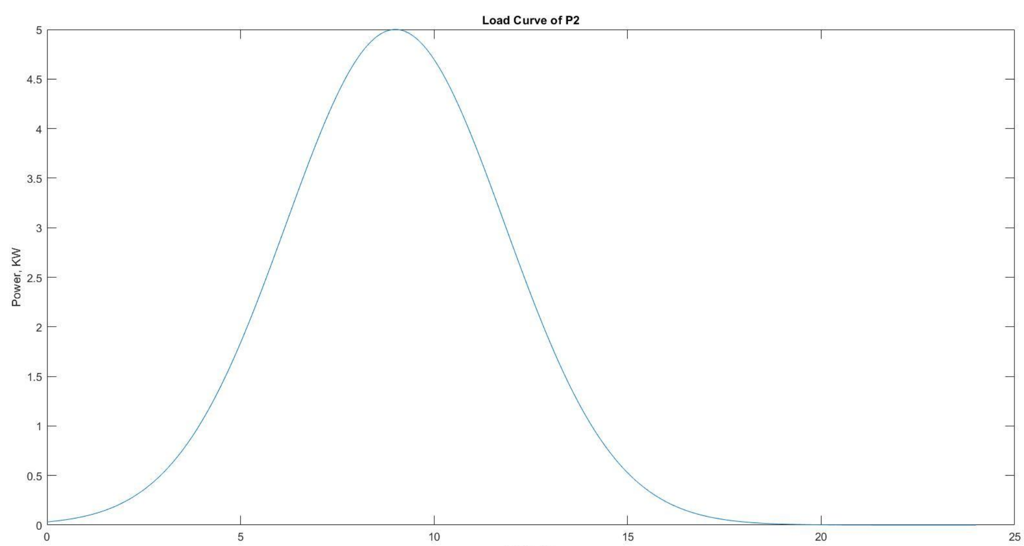
(a) The value of 'b' for which DF is max = 17.
Maximum Diversity Factor=3.2682

(b)

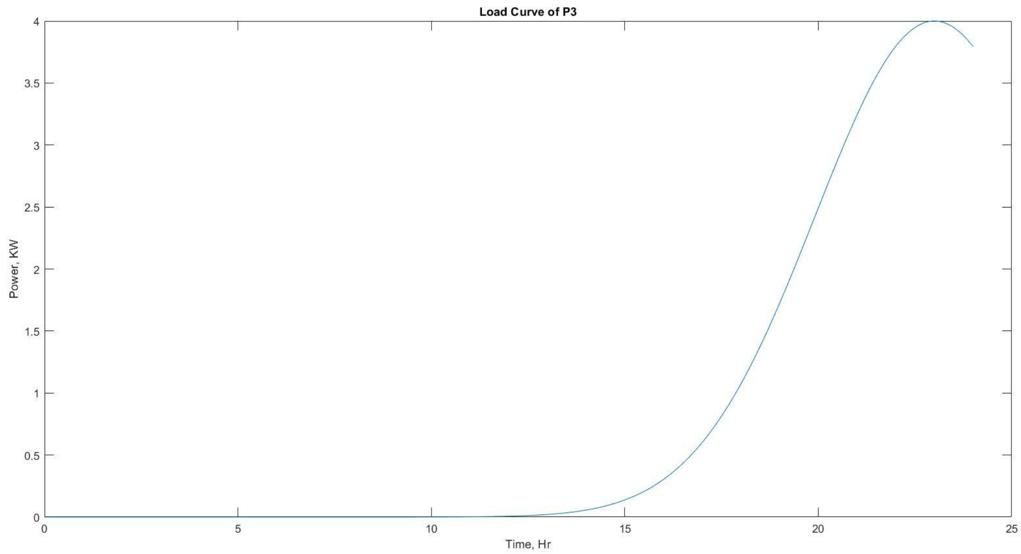
- Load Curve of P1:



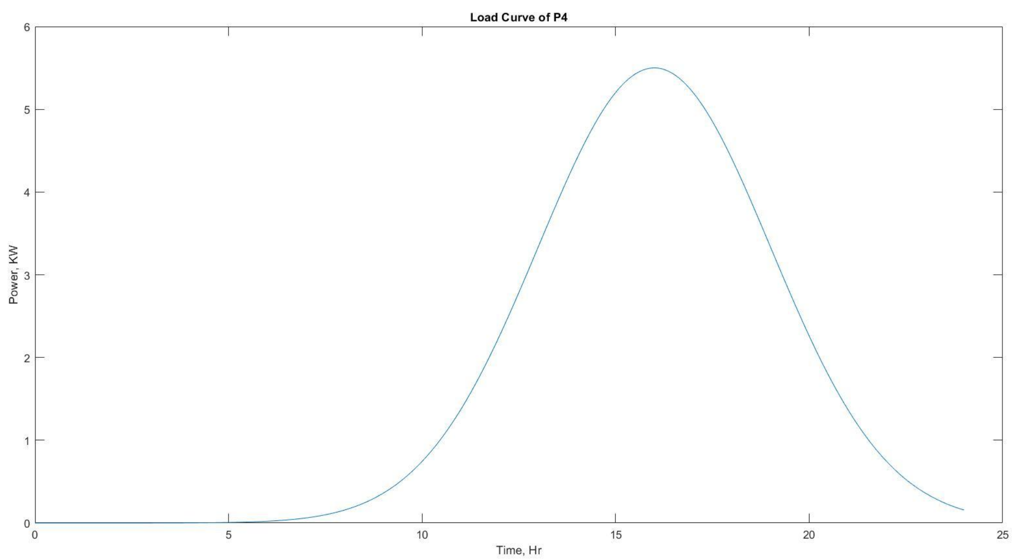
- Load Curve of P2:



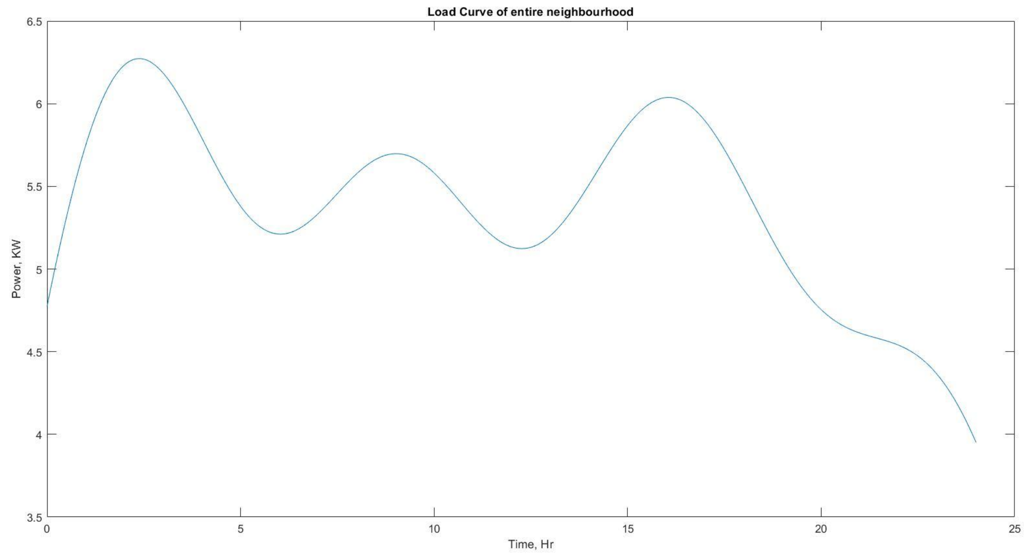
- Load Curve of P3:



- Load Curve of P4:



- Load Curve of the entire neighbourhood:



Theoretical Approach:

Time is represented in form of an array of size (1*4801),

Time=[0,0.005,0.010,0.015,.............k,k+0.005,........................23.995,24]

P1=[.....]

P2=[.....]

P3=[.....]

where P1, P2 and P3 are matrices of size (1*4801) in which each element represents the power calculated at the instant corresponding to the same index in the time array.

For example, $P1[j]=6e^{\frac{-(Time[j]-2)^2}{17}}\ kW$

where $j\epsilon I$is the index of the array.

Similarly, P2and P3 are defined.

Now, P4 is an array of size (25*4801) in which each row is corresponding to a different value of ‘b’ ranging from [0,24] and in each row different columns represent the power calculated at the instant corresponding to the same column index in the time array.

$$P4(i,j)\ =\ 5.5e^{\frac{-(Time[j]-bi\ )^2}{18}}\ kW$$

where $i, j\epsilon I$is the index of the array and $bi\ =\ i$,i.e. $b0\ =\ 0, b1\ =\ 1, b2\ =\ 2$,............, $b24\ =\ 24$.

Diversity Factor,

$$DF_b = \frac{max(P1)+max(P2)+max(P3)+max(P4_b)}{max(P1+P2+P3+P4_b)}$$

where $P4_b$, an array of size (1*4801), is a specific row of P4 corresponding to b value.

So, for all the values of b, we have calculated DF_b and observed that Diversity factor was maximum for $b = 17$ and maximum value of DF was 3.2682.

In part (b), corresponding to $b = 17$, We plotted required curves at all the instants given in the Time array.

Conclusion:

Thus, in the end, we learnt that the plots of Daily Load Curve and Load Duration Curve both have their own importance and can be used to classify the region depending on the peaks seen and also determining the generator size which would be needed to supply the load.

Other parameters such as Plant usage factor etc are also very critical since they tell us about the amount the plant has been used, what maximum capacity it can achieve etc. Plant capacity factor is most important as it is a good indicator of Reserve capacity.