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IQRA National University, Peshawar  
Department of Electrical Engineering  
Spring20  
Power Generation  
Assignment 1

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REG.No: 6997

Question No 1 (CLO-1)

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- A. A 100kVA distribution transformer costs Rs 2,00,000 and has an estimated useful life of 20 years. Find the annual depreciation amount, assuming that the scrap value of the transformer to be Rs 10,000.
- B. The average demand of a consumer is 40 A at 230 volts at unity power factor His total energy consumption annually is 10,000 KWh. If the unit rate is Rs 2 per kWh for the first 500hours use of the demand per annum plus Re 1 for each additional units, Calculate the annual bill of the consumer and equivalent flat rate.

Question No 2 (CLO-2)

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- A. A power station has to supply load as follows:

Timings	KW
11 pm to 5 am	500
5 am to 6 am	750
6 am to 7 am	1000
7 am to 9 am	2000
9 am to 12 noon	2500
12 Noon to 1 pm	1500
1 pm to 5 pm	2500
5 pm to 7 pm	2000
7 pm to 9 pm	2500
9 pm to 11 pm	1000

For the given data above draw the load curve. Select the number and size of generator units to supply this load. Find the reserve capacity of the plant required. Calculate the plant capacity factor. Determine the operating schedule of the units in the station. Calculate the plant factor?

Ans

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### Question No: 1

A) A 100 KVA distribution Transformer Costs Rs 2,00,000 and has an estimated useful life of 20 years. Find the annual depreciation amount, assuming that the scrap value of the Transformer to be Rs 10,000.

Sol: Given Data:

$$P = 2,00,000$$

$$S = 10,000$$

$$N = 20 \text{ years.}$$

$$\begin{aligned} \text{Depreciation } D &= \frac{(P - S)}{n} \\ &= \frac{2,00,000 - 10,000}{20} \\ &= \text{Rs } 9500 \text{ annually.} \end{aligned}$$

X ————— X

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B) The average demand of a consumer is 40A at 230 volts at Unity power factor His Total energy consumption annually is 10,000 kWh. If the Units Rate is Rs 2 per kWh for the first 500 hours use of the demand per annum plus Re 1 for each additional Units, calculate the annual bill of the consumer and equivalent flat rate -

Given : Energy :  $E = 10000 \text{ kWh}$ .

Current :  $I = 40 \text{ A}$ .

Voltage =  $V = 230 \text{ volts}$ .

The Power Demand of the consumer is

$$P = VI \cos \phi = 230 \times 40 \times 1 = 9200 \text{ W}$$

or  $9.2 \text{ kW}$  -

Electricity consumption for the first 500 hours is =  $500 \times 9.2 = 4600 \text{ kWh}$ .

Since the cost of electricity is Rs 2 per kWh of for the first 500 hours,

Therefore the consumer has to pay:



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$$4600 \times 2 = \text{Rs } 9200.$$

For the remaining Units, that is:  
(10,000 - 4600) = 5,400 Consumer has

To pay  $5400 \times 1 = \text{Rs } 5400$

$$\begin{aligned} \text{Annual bill is therefore} &= 9200 + 5400 \\ &= \text{Rs } 14600 \end{aligned}$$

The flat rate equivalent is:

$$= 14600 / 10,000$$

$$= \text{Rs } 1.46 \text{ per kWh.}$$

X ————— X

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### Question No: 2

A) A Power station has to supply load as follows:

Solution: The maximum demand is 2500kW.

If water resources were not available in the vicinity the plant would normally be diesel-electric. For a privately owned plant it could be a steam station if local conditions were suitable. The method and considerations for the selection of size of generating units are, however, common to all types of stations as far as fitting in the load curve is concerned.

$$\begin{aligned} &\Rightarrow \text{Energy generated during 24 hours.} \\ &= (500 \times 5) + (750 \times 1) + (1000 \times 1) + (2000 \times 2) + (2500 \times 3) \\ &+ (1500 \times 1) + (2500 \times 4) + (2000 \times 2) + (2500 \times 2) + \\ &(1000 \times 2) + (500 \times 1) \\ &= 38750 \text{ kWh.} \end{aligned}$$

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Maximum demand = 2500 kW.

$$\text{Load factor} = \frac{\text{Energy generated during 24 hours}}{\text{Maximum demand} \times 24 \text{ hours}}$$

$$= \frac{38,750}{2500 \times 24}$$

$$= 64.7\%$$

From the nature of load curve, it will be seen that this is the load of a small industrial town, well distributed during day and night. From the load curve it will also be seen that three generator sets will suffice with the following ratings.

Two sets each of 1000 kW Capacity.

One set of 500 kW Capacity.

The Reserve Capacity required will correspond to the largest size of the unit in the station. I.N This



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In this case, a set of 1000 kW will have to be bought and kept as reserve. The total installed capacity of the station will, therefore be  $1000 + 1000 + 500 + 1000$  (Reserve), i.e. 3500 kW.

$$\text{Plant Capacity factor} = \frac{\text{Energy Produced during 24 hours (kWh)}}{\text{Installed Capacity (kW)} \times 24 \text{ hours}}$$

$$= \frac{38,750}{3500 \times 24} \Rightarrow 0.46 \text{ or } 46\%$$

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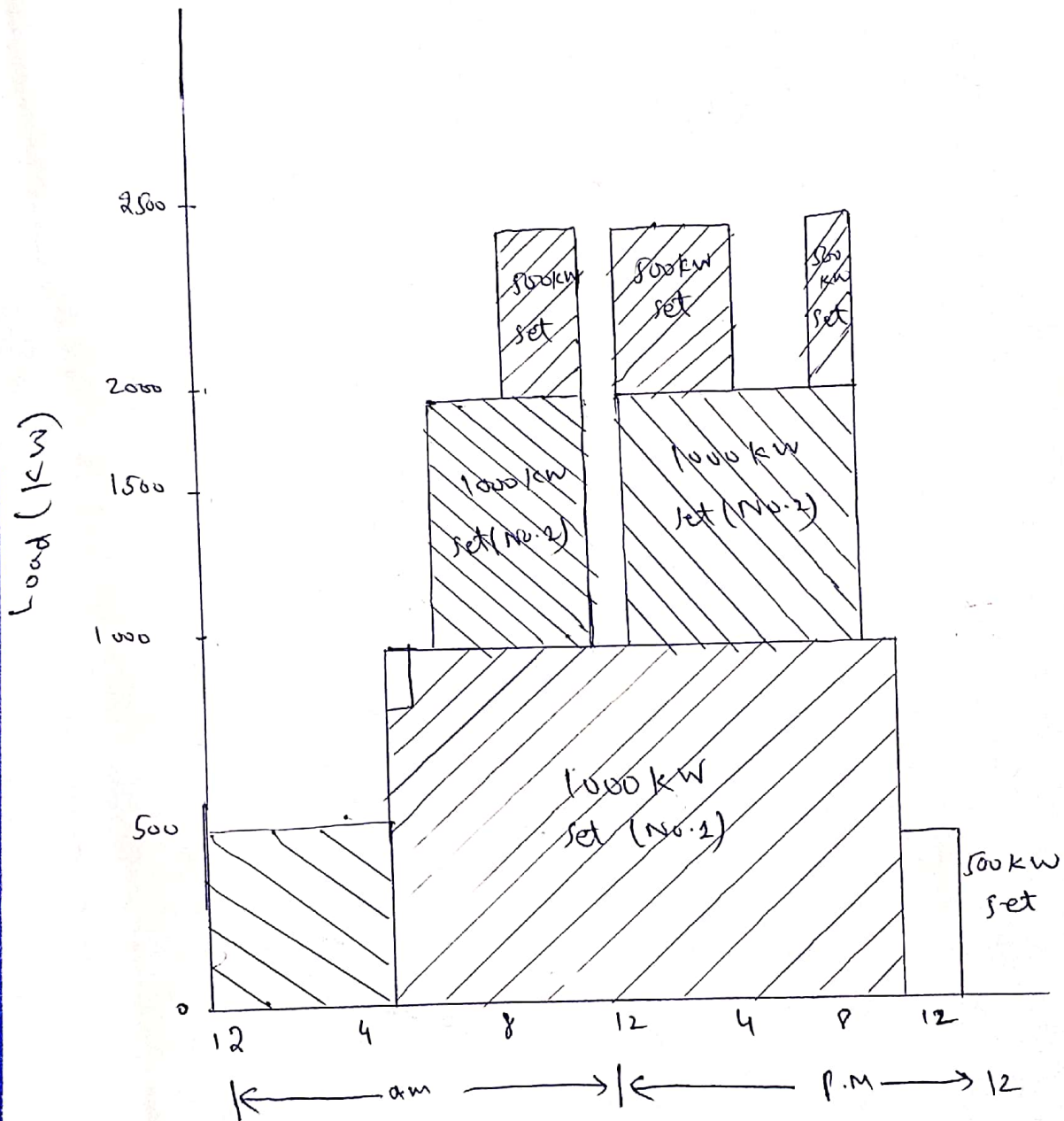


Figure 2.1 Load curve of a Power station.



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The capacity of the individual sets is chosen as possible to fit approximately the load curve. Next it should be decided how, when and in what sequence the sets should be started and run. This arrangement is known as the operating schedule of the station. In arranging this schedule, care is taken to see that the plant of the required capacity is kept ready for loading at the expected time of the load. The capacity of the plant started and kept ready might be larger than necessary but should not be inadequate with the type of load curve shown in Figure 2.1 and the sizes of units selected as above, the operating schedule can be arranged as follows -

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From 11.P.M to 5am only the 500kw set is run.

At 5am the load is expected to increase - The first 1000kw set is, therefore, started and parallel with the 500 kw set, all the load is transferred to the 1000kw set, and then the 500 kw set is stopped.

Thus one set of 1000 kw is run from 5 am to 7am, taking up the necessary load, just before 7am when an increase in load is expected the second 1000 kw set is started and parallel with the first one -

From 7 a.m to 9 a.m both the 1000 kw sets are running together



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At 9 am still more load is expected the 500 kW set is started and paralleled with the other set on busbars and loaded with them. Thus at the time of supplying the maximum load between 9 a.m and 12 noon. all the three sets are running on full load -

between 12 noon and 2 P.M the load decreases, owing to process. lunch time in industrial plants. one of the 1000 kW set is stopped after the load has dropped to 1500 kW.

From 2 P.M to 5 P.M this set is run again along with the two others -

At 5 P.M the load again drops, owing to the working shift in industrial being over -



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The load on the 500 kW set is removed and then this set is taken out of Commission -

From 5 P.M to 7 P.M only both the 1000 kW sets are running -

At 7 P.M The load increases, owing to lighting all the three sets are run until 9 P.M -

At 9 P.M The load increases, owing to lighting all the three sets -

After 11 P.M only the 500 kW set need be run -

At each time of change-over Care should be taken to ensure correct paralleling and load transfer -

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With the operating schedule fixed as above the energy that could have been generated by the capacity of plant actually running for the scheduled time would be,

$$\begin{aligned}
 & (500 \times 6) + (1000 \times 2) + (2000 \times 2) + (2500 \times 3) \\
 & + (1500 \times 1) + (2500 \times 4) + (2000 \times 2) + (2000 \times 2) \\
 & + (1000 \times 2) = 39000 \text{ kW}
 \end{aligned}$$

$$\text{Energy actually produced} = 38750 \text{ kW}$$

$$\text{Plant Use for} = \frac{\text{Energy Produced (kW)}}{\text{Capacity of Plant (kW)} \times \text{No. of hours plant has been in operation}}$$

$$= \frac{38750}{39000} = 0.994 \text{ or } 99.4\%$$

X ————— X