



**Question No 1 (CLO -1)**

**13976**

**20**

- 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)**

**10**

- 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?

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1PART (A)

Given that :

$$P = 2,00,000$$

$$S = 10,000$$

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

$$\text{Depreciation } D = (P - S) / n = \frac{2,00,000 - 10,000}{20}$$

$$D = \text{Rs } 9,500 \text{ annually}$$

## PART (B)

Given :Energy :  $E$  10000 KwhCurrent :  $I$  40 AVoltage :  $V$  230 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 :  $4600 \times 2 = \text{Rs } 9200$
- ⇒ For the remaining units, that is :  $(10,000 - 4600) = 5,400$ , consumer has to pay  $5400 \times 1 = \text{Rs } 5400$
- ⇒ Annual bill is therefore :  $9200 + 5400 = \text{Rs } 14,600$
- ⇒ The flat rate equivalent is :  $14600 / 10,000 = \text{Rs } 1.46 \text{ per Kwh}$ .



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2Solution :

In a given load curve plotted from the above data. The maximum demand 2500 Kw. If water resource were not available in the ~~vicinity~~ 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 & considerations for the selection of size of generating units are, however, common to all types of stations so far as fitting in the load curve is ~~concerned~~ concerned.

$$\begin{aligned}
 &\text{Energy generated during 24 hours} \\
 &= (500 \times 5) + (750 \times 1) + (1000 \times 1) + (2000 \times 2) + (2500 \times 3) + \\
 &+ (1500 \times 1) + (2500 \times 4) + (2000 \times 2) + (2500 \times 2) + (1000 \times 2) \\
 &+ (500 \times 1) \\
 &= 2500 + 750 + 1000 + 4000 + 7500 + 1500 + 10,000 + 4000 \\
 &\quad + 5000 + 2000 + 500 \\
 &= 38,750 \text{ Kwh}
 \end{aligned}$$

$$\text{Maximum demand} = 2500 \text{ Kw}$$

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

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

$$\text{Load factor} = 64.7\%$$

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

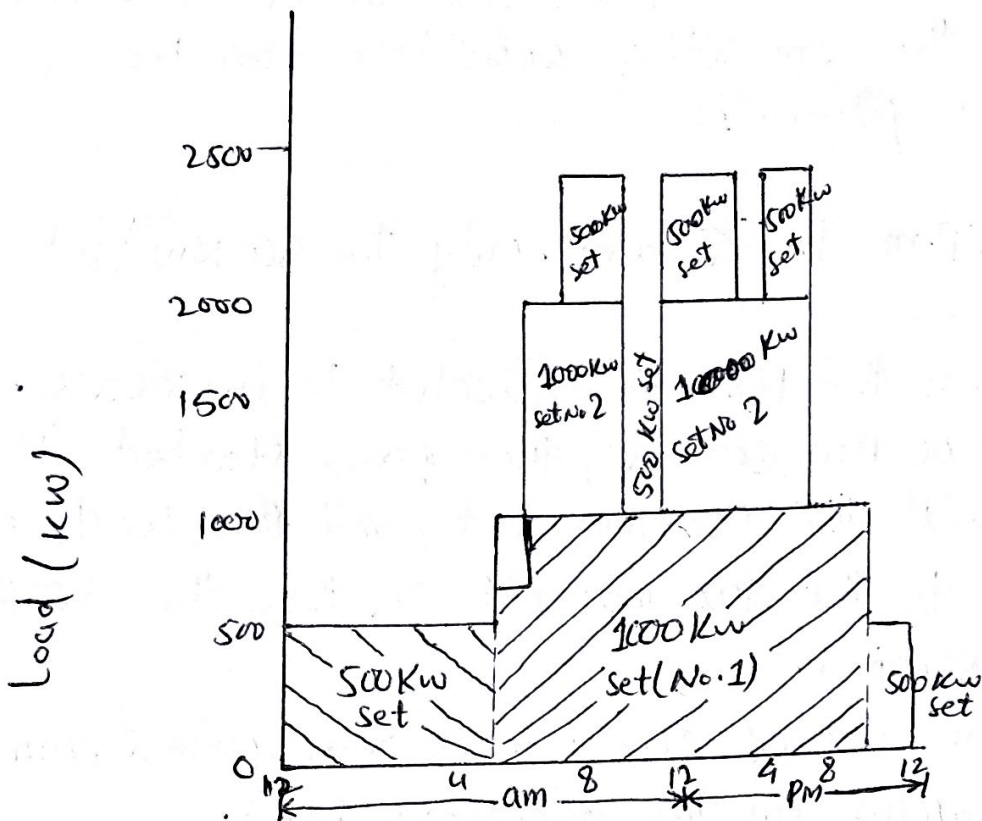
Two sets each of 1000 Kw Capacity

One set of 500 Kw Capacity

The reserve capacity required will correspond to the largest size of the unit in the station. In this case a set of 1000 Kw will have to be bought & kept as reserve. The load installed capacity of the station will, therefore, be  $1000 + 1000 + 500 + 1000$  (reserve), i.e., 3500 Kw.

$$\begin{aligned} \text{Plant capacity factor} &= \frac{\text{Energy produced during 24 hours (Kwh)}}{\text{Installed capacity (Kw)} \times 24 \text{ hours}} \\ &= \frac{38,750}{3500 \times 24} = 0.46 \text{ or } 46\% \end{aligned}$$





Load curve of a power station.

The capacity of the individual sets is chosen ~~as~~ as far as possible to fit approximately the load curve. Next it should be ~~decided~~ decided how, when & in what sequence the sets should be started & 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 & kept ready might be larger than necessary but should not be inadequate.

With the type of load curve shown in above load curve & the sizes of units selected as above, the operating schedule can be arranged as follows:

From 11 p.m. to 5 a.m. Only the 500 Kw set is run.

At 5 a.m. the load is expected to increase. The first 1000 Kw set is, therefore, started & paralleled with the 500 Kw set, all the load is transferred to the 1000 Kw set & then the 500 Kw set is stopped.

Thus one set of 1000 Kw is run from 5 a.m. to 7 a.m. taking up the necessary load.

Just before 7 a.m. when an increase in load is expected, the second 1000 Kw set is started & parallel with first one.

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

At 9 a.m. still more load is expected, the 500 Kw set is started & paralleled with the ~~other~~ other sets on the busbars & loaded along with them. Thus at the time of supplying the maximum load, b/w 9 a.m. & 12 noon, all the three sets are running on full load.



Between 12 noon & 1 p.m. the load decreases, owing to recess - lunch time - in industrial plants.

One of the 1000 Kw sets is stopped after the load has dropped to 1500 Kw.

From 1 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 industries being over. The load on the 500 Kw set is removed & then this set is taken out of commission.

From 5 p.m. to 7 p.m. only both the 1000 Kw Set 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. two sets are taken out of & only one 1000 Kw is run until 11 p.m.

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 & load transfer.

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



$$\begin{aligned} & (500 \times 6) + (1000 \times 2) + (2000 \times 2) + (2500 \times 3) + (1500 \times 1) \\ & + (2500 \times 4) + (2000 \times 2) + (2500 \times 2) + (1000 \times 2) = \\ & = 3000 + 2000 + 4000 + 7500 + 1500 + 10,000 \\ & \quad + 4000 + 5000 + 2000 \\ & = 39000 \text{ Kwh} \end{aligned}$$

Energy actually produced = 38,750 Kwh

$$\text{Plant use factor} = \frac{\text{Energy produced (Kwh)}}{\text{Capacity of plant (kw) \times Number of hours Plant has been in operation.}}$$

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

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