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Power Generation
Assignment I

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

PART A :-

Q A 100KVA a distribution transformer costs Rs 2,00,000 and has estimated useful life of 20 years. Find the annual depreciation amount, assuming that the scrap value of the transformer to be Rs 10,000.

SOLUTION :-

Given data :-

$P = 2,00,000$
Scrap value, $S = 10,000$
No of years, $N = 20$ years

Required :-

Depreciation, $D = ?$

Formula + Solution :-

$$D = \frac{(P-S)}{n}$$

putting values

$$D = \frac{2,00,000 - 10,000}{20}$$

$$\boxed{D = 9,500}$$

Depreciation value $D = 9,500$ Rs annually.

PART B:-

Q 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 500 hours use of the demand per annum pulse Rs 1 for each additional units, Calculate the annual bill of the Consumer and equivalent flat rate ?

SOLUTION :-

Given data:-

Energy , E = 10,000 KWh
Current , I = 40 A
Voltage , V = 230 volts

Required :-

Annual bill = ?
Equivalent flat rate = ?

Solution :-

First we find power.

$$P = VI$$
$$= 230 \times 40$$
$$\boxed{P = 9200\ W} \text{ or } \boxed{9.2\ KW}$$

Now, for the first 500 hours electricity consumed is.

$= 500 \times 9.2$

$= 4600$ KWh

If the cost of electricity is Rs 2 per KWh for the first 500 hours, therefore the consumer has to pay:

$= 4600 \times 2$

$= 9200$ Rs

Total energy $E = 10,000$ KWh

Energy of first 500 hours $= 4600$ KWh

So,

Remaining units $= 10,000 - 4600$

$= 5,400$ KWh

Now for Rs 1,

Consumer has to pay $= 5400 \times 1$

$= 5400$ Rs

Annual bill $= 9200 - 5400$

$= 14,600$ Rs

Equivalent flat rate $= \frac{14,600}{10,000}$

$=$ Rs 1.46 per KWh

Annual bill = 14,600 Rs
Equivalent flat rate = Rs 1.46 per KWh

QUESTION 2 :-

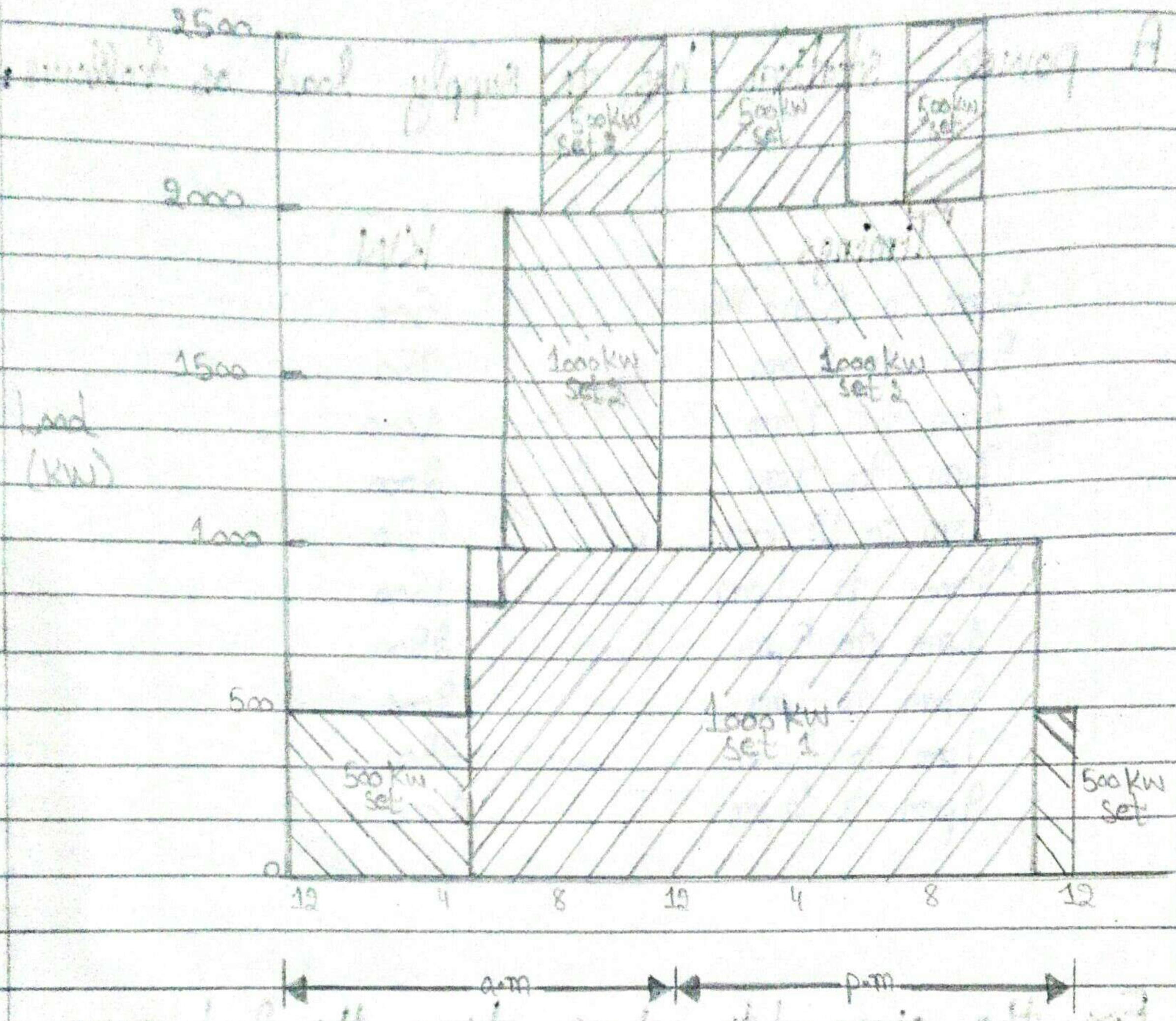
Q A power station has to supply load as follows:

Timings	KW
11pm 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 1pm	1500
1pm to 5pm	2500
5pm to 7pm	2000
7pm to 9pm	2500
9pm to 11pm	1000

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

SOLUTION :-

Load Curve of power station :-



Selection of size of generator units to supply the load :-

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" generators sets will suffice with the following ratings.

1, Two sets each of 1000 KW capacity.
2, One set of 500KW capacity.

Reverse Capacity of the plant :-

For reverse capacity first we find energy generated during 24 hours.

So,

Energy generated during 24 hours :-

= (500 x 5) + (750 x 1) + (1000 x 1) + (2000 x 2) + (2500 x 3) + (1500 x 1) + (2500 x 4) + (2000 x 2) + (2500 x 2) + (1000 x 2) + (500 x 1)

= 2500 + 750 + 1000 + 4000 + 7500 + 1500 + 10,000 + 4000 + 5000 + 2000 + 500

= 38,750 KWh

Now,

Installed capacity :-

In the load curve a set of 1000 KW will have be bought and kept as reverse. So the installed capacity of the station is.

1000 + 1000 + 500 + 1000 (reverse) = **3500 KW**

Installed capacity = 3500 KW.

So,

the reverse capacity or installed capacity is **3500 KW**

Plant Capacity factor :-

$$\text{Plant Capacity factor} = \frac{\text{Energy produced in 24 hours}}{\text{installed Capacity} \times \text{24 hours}}$$

As we know,

Energy produced in 24 hours = 38,750 KWh and installed capacity is 3500 KW.

$$\text{Plant Capacity factor} = \frac{38,750}{3500 \times 24}$$

$$= 0.46$$

or

46%

Operating Shedule :-

The operating Schedule can be arranged as follows:-

1, From 11 pm to 5 am only the 500KW set is run.

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

2, The one set of 1000 KW is run from 5am to 7am, taking up the necessary load.

Just before 7am when [redacted] increase load is expected, the second 1000 KW set is started and parallel with first one.

3, From 7am to 9am both the 1000 KW sets are running together.
At 9am still more load is expected, the 500 KW set is started and parallel with the other sets on the busbars and loaded along with them. Thus at the time of supplying the maximum load between 9am and 12 noon, all the three sets are running on full load.

4, Between 12 noon and 1 pm, the load decreases owing to recess - lunch time in industrial plants. One of the 1000 KW set is stopped after the load has dropped to 1500 KW.

5, From 1pm to 5pm this set is run again along with the two others.
At 5pm the load again drops, owing to the working shift in industries being over. The load on the 500 KW set is removed and this set is taken out of commission.

6, From 5pm to 7pm only both the 1000 KW sets are running.
At 7pm the load increases, owing to the lighting and all the three sets are run until 9 pm.

7, At 9pm two sets are taken out and only one 1000 KW is run until 11 pm.

8, At 11 pm only the 500 KW set need to be run.
At each time of change-over, care should be taken to ensure correct paralleling and load transfer.

Plant factor :-

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

= (500 x 6) + (1000 x 2) + (2000 x 2) + (2500 x 3) + (1500 x 1) + (2500 x 4) + (2000 x 2) + (2500 x 2) + (1000 x 2)

= 39,000 KWh

Energy actually produced = **38,750 KWh**

$$\text{Plant factor} = \frac{\text{Energy produced (KWh)}}{\text{Capacity of plant}}$$

$$= \frac{38,750}{39,000}$$

= **0.994** or **99.4 %**

THE END