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

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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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Q1

(A) A 100 KVA distribution transformer costs Rs 2,00,000 and has an estimated usefull 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:

Initial cost of transformer, P = Rs 2,00,000
useful life, n = 20 years.

Salvage value (scrap value), S = Rs 10,000

Required data:

Annual depreciation charge = ?

solution:

Using straight line method,

$$\boxed{\text{Annual depreciation charge (D)} = \frac{(P-S)}{n}}$$

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

$$\boxed{D = \text{Rs } 9500}$$

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Q1

(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 unit rate is Rs 2 per kWh for the first 500 hours use of the demand per annum plus Rs 1 for each additional units, calculate the annual bill of the consumer and equivalent [illegible] flat rate.

Sol:-

Given data:

Energy (E) = 10,000 kWh,
Current (I) = 40 A
voltage (V) = 230 V

solution:

Assume the load factor and power factor to be unity.

Maximum power demand (P) : $P = VI\cos\phi$

$P = 230 \times 40 \times 1 = 9200\,W = 9.2\,kW$

$\boxed{P = 9.2\,kW}$

(i) Units consumed in first 500 hrs = power × Time

Energy $= 9.2 \times 500 = 4600\,kWh$

Since the cost of electricity is Rs 2, per kWh for the first 500 hrs, Therefore the consumer has to pay;

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charges for 4600 kwh = Rs 2 × 4600
= Rs 9200

Remaining units = 10,000 − 4600
= 5400 kwh

charges for Remaining 5400 kwh = Rs 1 × 5400
= Rs 5400

Total annual bill = Rs (9200 + 5400)
= Rs 14600

(ii) Equivalent flat rate = $\frac{\text{Total bill}}{\text{Energy}}$

$= \frac{14600}{10,000}$

= Rs 1.46 per kwh

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Q2 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 the generator unit to the 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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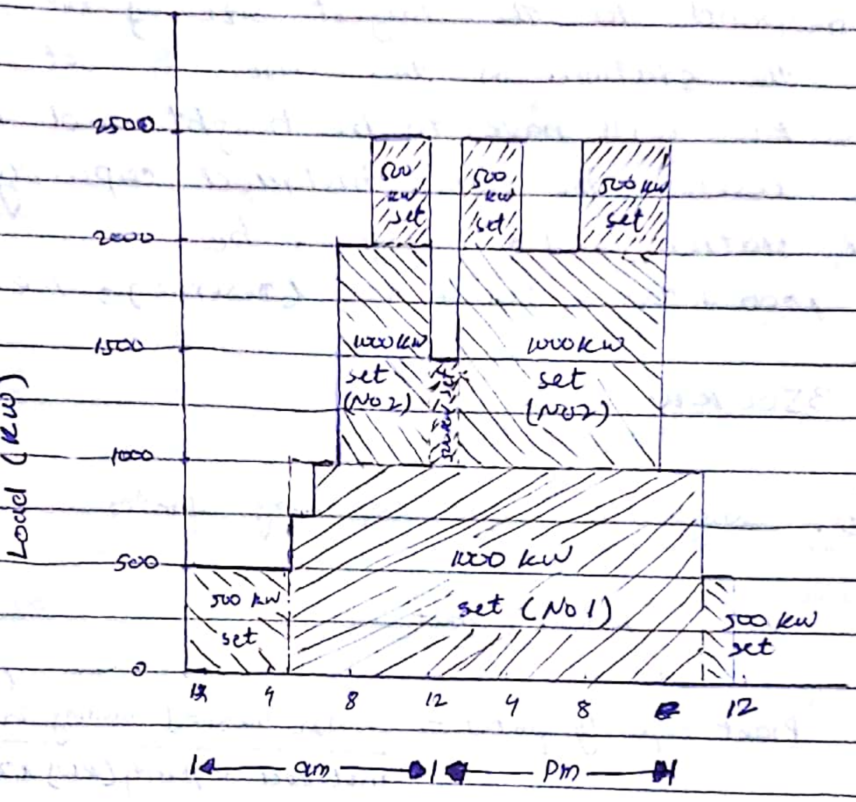
Sol:-

① Draw the load curve:



Load curve of a power station

② select the number & size of generator units the supply this load:

From the nature of the 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

③ Find the reserve capacity of the plant required:

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 baught and kept as reserve. The total installed capacity of the station will, therefore, be

1000 + 1000 + 500 + 1000 (reserve), i.e.

3500 kW

④ Calculate plant capacity factor.

we know that

$$\text{Plant capacity factor} = \frac{\text{Energy produced during 24 hrs (kWh)}}{\text{Installed capacity (kW)} \times 24 \text{ hrs}}$$

So,

Energy produced during 24 hrs:

$$= (500\times5)+(750\times1)+(1000)+(2000\times2)$$
$$+(2500\times3)+(1500\times1)+(2500\times4)+(2000\times2)$$
$$+(2500\times2)+(1000\times2)+(500\times1)$$

$$= 38{,}750 \text{ kWh}$$

and,

Installed capacity (kW) = 3500 kW

Now

$$\text{Plant capacity factor} = \frac{38{,}750}{3500\times24} = 0.46$$

plant capacity factor = 46%

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⑤ Operational schedule:

The capacity of the individual sets is chosen as far as possible to fit approximately the load curve. Next it should be decided how, when and in what sequence the sets should 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 above figure and the sizes of units selected as above, the operating schedule can be arranged as follows:

From 11p.m to 5a.m only the 500kw set is run.

At 5a.m the load is expected to increase. The first 1000kw set, and then the 500kw set is stopped

Thus one set of 1000kw is run from 5am to 7am taking up the necessary load.

Just before 7am when an increase in load is expected, the second 1000kw set is started and paralleled with the first one.

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

At 9am still more load is expected, the 500kw set is started and parallaled with the other sets on the busbars and loaded along with them.

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Thus at the time of supplying the maximum loads, between 9am and 12 noon, all the three sets are running on full load.

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

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 500kw set is removed and then this set is taken out of commission.

From 5pm to 7pm only both the 1000kw sets are running.

At 7pm the load increases, owing to lighting and all the three sets are run until 9 pm.

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

After 11pm only the 500kw set need be run.

At each time of change-over, care should be taken to ensure correct paralleling and 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 scheduled time would be

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⑨

$(500\times6)+(1000\times2)+(2000\times2)+(2500\times3)$
$+(1500\times1)+(2500\times4)+(2000\times2)$
$+(2500\times2)+(1000\times2) = \underline{\underline{39,000\ kWh}}$

Energy actually produced = 38,750 kWh

⑥ Plant factor :

we know that

$$\text{Plant use factor} = \frac{\text{Energy produced (kWh)}}{\text{Plant capacity (kW)} \times \text{hrs of use}}$$

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

$$= 0.994$$

plant use factor = 99.4 %