(5) A single phase, 50-Hz, 200 KVA, 11 kV./230 V. transformer gave the following test results :-

No-load : Normal voltage applied ; input = 1,600 W.

Short circuit : Rated current flowing with reduced voltage applied = 2,600 W.

Calculate the all-day efficiency if the duty cycle of the transformer is as follows :- 160 kW. at 0.8 P.f. for 8-hours, 100 kW at unity P.f. for 6-hours and no-load for rest of the day.

Soln. :- Energy out put in one day

$= 160 \times 8 + 100 \times 6 + 0 \times 10 = 1880$ kWh.

Energy loss due to core loss in one day

$= 1.6 \times 24 = 38.4$ kWh.

Energy loss due to copper losses

= 8-hours on full load + 6-hours on half full load

$$= 8\times 2.6 + 1\times 2.6\times\left(\frac{1}{2}\right)^2 = 24.7 \text{ KWh.}$$

$\therefore$ Total energy input $= 1880 + 38.4 + 24.7$

$= 1943.1$ KWh.

$\therefore$ All-day efficiency $= \dfrac{\text{out put in KWh.}}{\text{Input in KWh.}}$

$$= \frac{1880}{1943.1}\times 100\% = 96.8\%.$$

(b) A 100 KVA, 50-Hz., 440V./11,000V. single phase transformer has an efficiency of 98.5% when supplying full-load current at 0.8 p.f. and an efficiency of 99% when supplying half-load current at unity p.f. Find the iron losses and the copper losses corresponding to full-load current. At what value of load current will the maximum efficiency be attained?

Soln:- Let the copper loss at full-load $= W_c$ KW.

and the iron loss $= W_i$ KW.

$$\therefore \frac{100\times 0.8}{100\times 0.8 + W_c + W_i} = 0.985 \quad \text{— (1)}$$

and
$$\frac{50\times 1}{50\times 1 + \left(\frac{1}{2}\right)^2 W_c + W_i} = 0.990 \quad \text{— (2)}$$

From (1) $\rightarrow$ $0.985 W_c + 0.985 W_i = 80 - 78.8$

$\Rightarrow$ ~~0.78~~ $W_c + W_i = 1.218$ — (3)

From (2) $\rightarrow$ $\dfrac{W_c}{4} + W_i = 0.505$

$\Rightarrow W_c + 4 W_i = 2.02$ — (4)

(4) — (3) $\Rightarrow$ $3 W_i = 0.802$

$\Rightarrow W_i = 0.2673$ KW $= 267.3$ W.

From (3) $\rightarrow$ $W_c = 0.9507$ KW. $= 950.7$ W.

Let, maximum efficiency occurs at a fraction of x times the full-load.

$\therefore$ $x^2 W_c = W_i \Rightarrow x^2\times 950.7 = 267.3$

$\Rightarrow x = 0.5302.$

$\therefore$ Maximum efficiency occurs at a load of (0.5302×100) KVA. $= 53.02$ KVA i, Full-load current on the primary side

$$= \frac{100 \times 1000}{440} = 227\ A.$$

$\therefore$ Current at maximum efficiency $= (227 \times 0.5302)\ A$

$$= 120.36\ A.$$