Example 9: A Transformer has hysterisis loss of 30 watts at 240V, 60 Hz supply. The Hysterisis loss at 200V, 50Hz supply is

(a) 30 W (b) 25 W

(c) 60 W (d) 100 W

Sol: $V_1 = 240v$, $f_1 = 60H$ and $V_2 = 200V$, $f_2 = 50Hz$

$$\frac{V_1}{f_1} = \frac{V_2}{f_2} = 4$$

$$\frac{v}{f} = \text{cons tan t}$$

$$w_h \propto f.$$

$$\frac{w_{h2}}{w_{h1}} = \frac{f_2}{f_1}$$

$$w_{h2} = \frac{50}{60} \times 30$$
$$= 25W$$

Example 10: A Transformer has iron loss of 90 watts at 60 Hz supply and 52 watts at 40Hz supply. Both losses being measured at same peak flux density. The total iron loss in the Transformer at 50Hz supply will be

(a) 70 W (b) 90 W

(c) 50 W (d) 60 W

Sol: $w_i = 90w \rightarrow 60Hz$

$w_i = 52w \rightarrow 40Hz$

$B_m = \text{constant}$

$$W_i = Af + Bf^2$$

$90 = A(60) + B(60)^2$
$52 = A(40) + B(40)^2$
By solving above two equations A = 0.9 and B = 0.01
$W_i = 0.9 \times 50 + 0.01\times(50)^2$
$= (45 + 25) = 70w$

Example 11: A 220V, 60Hz single phase Transformer has hysterisis loss of 340 Watts and eddy current loss of 120 Watts. If the Transformer is operated from 200V, 50Hz supply mains, the total Iron loss in the transformer will be

(a) 525 W (b) 375 W
(c) 325 W (d) 425 W

Sol: V_1= 220V, f_1= 60Hz, V_2= 200V, f_2= 50Hz
$w_{h1} = 340w$
$w_{e1} = 120w$

$$\frac{V_1}{f_1} \neq \frac{V_2}{f_2}$$

$W_h \propto V^{1.6} \times f^{-0.6}$ and $W_e \propto V^2$.

Total iron loss w_i

$$= w_{h1} \times \left(\frac{V_2}{V_1}\right)^{1.6} \times \left(\frac{f_2}{f_1}\right)^{-0.6} + w_{e1}\left(\frac{V_2}{V_1}\right)^2$$

$$= 340 \times \left(\frac{200}{220}\right)^{1.6} \times \left(\frac{50}{60}\right)^{-0.6} + 120\left(\frac{200}{220}\right)^2$$

$= 425W$

Example 12: A 230V, 50 Hz single phase Transformer has eddy current loss of 30 Watts. If the transformer is excited with DC source of same magnitude will be

(a) 30 W (b) 25 W
(c) 0 W (d) None of the above

Sol: No emf in core
$\Rightarrow$ Eddy current loss = 0W

Example 13: The Hysterisis and eddy current losses of a single phase Transformer when operated from 240V, 60 Hz supply are Ph and Pe respectively. The percentage decrease in these losses when the transformer is operated from 200V, 50 Hz supply are

(a) 16.6%, 30.5% (b) 30.3%, 16.6%
(c) 25.5%, 30.3% (d) 16.6%, 28.6%

Sol: $\frac{V}{f}$ ratio is constant.
$P_h \propto f$ and $P_e \alpha f^2$

$$\frac{P_{h1} - P_{h2}}{P_{h1}} \times 100 = \frac{60-50}{60} \times 100$$

$$\frac{P_{e1} - P_{e2}}{P_{e1}} \times 100 = \frac{60^2 - 50^2}{60^2} \times 100$$

$= 16.6\%$
$= 30.5\%$

Example 14: A 50Hz single phase transformer has equal hysterisis and eddy current losses at rated excitation. If the transformer is operated at 50 Hz and at 90% of rated excitation, the percentage reduction in the iron loss when compared with iron at rated excitation is

(a) 17.3% (b) 19.5%
(c) 18.6% (d) 10%

Sol: Given, equal Hysterisis loss and eddy current loss.

$$W_{h1} = W_{e1} = \frac{W_i}{2}$$

$$\frac{V_1}{f_1} \neq \frac{V_2}{f_2}$$

$W_h \propto V^{1.6} \times f^{-0.6}$ and $W_e \propto V^2$.
Total iron loss w_{i2}

$$= w_{h1} \times \left(\frac{V_2}{V_1}\right)^{1.6} \times \left(\frac{f_2}{f_1}\right)^{-0.6} + w_{e1}\left(\frac{V_2}{V_1}\right)^2$$

$$= \frac{w_i}{2} \times \left(\frac{90}{100}\right)^{1.6} \times \left(\frac{50}{50}\right)^{-0.6} + \frac{w_i}{2}\left(\frac{90}{100}\right)^2$$

$= 0.827\ W_i$

Example 17: A single phase transformer on open circuit condition gave the following test results:

Applied voltage	Frequency	Power drawn
192 V	40 Hz	39.2 W
288 V	60 Hz	73.2 W

Assuming Steinmetz exponent n = 1.6, find out the hysteresis and eddy current loss separately if the transformer is supplied with 240 V, 50 Hz.

Sol: Given $V_1 = 193v$ $\quad$ $V_2 = 288v$

$f_1 = 40Hz$ $\quad$ $f_2 = 60Hz$

$w_i = 39.2w$ $\quad$ $w_i = 73.2w$

$$\frac{v_1}{f_1} = \frac{v_2}{f_2} = 4.8$$

$$w_i = Af + Bf^2 \qquad [\because \frac{v}{f} = \text{constant}]$$

$A(40) + B(1600) = 39.2$

$A(60) + B(3600) = 73.2$

By solving above two equations A = 0.5 and B = 0.012.

At 192v, 40Hz:

$w_h = Af = 0.5\times40 = 20W$ and

$w_e = Bf^2 = 0.012\times40^2 = 19.2W$

$V_3 = 240V$ and $f_3 = 50Hz$

$$\frac{v_3}{f_3} = 4.8.$$

$$W_{h2} = W_{h1} \times \frac{f_2}{f_1}$$

$$W_{e2} = W_{e1} \times \left(\frac{f_2}{f_1}\right)^2$$

$$W_{h2} = 20\times\frac{50}{40}$$

$$W_{e2} = 19.2\times\left(\frac{50}{40}\right)^2$$

$= 25w$ $= 30w.$