Ministry of Higher Education
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تكنولوجيا الكهرباء

Electrical Technology

Lecture 3

Lecture Name: TRANSFORMER

By

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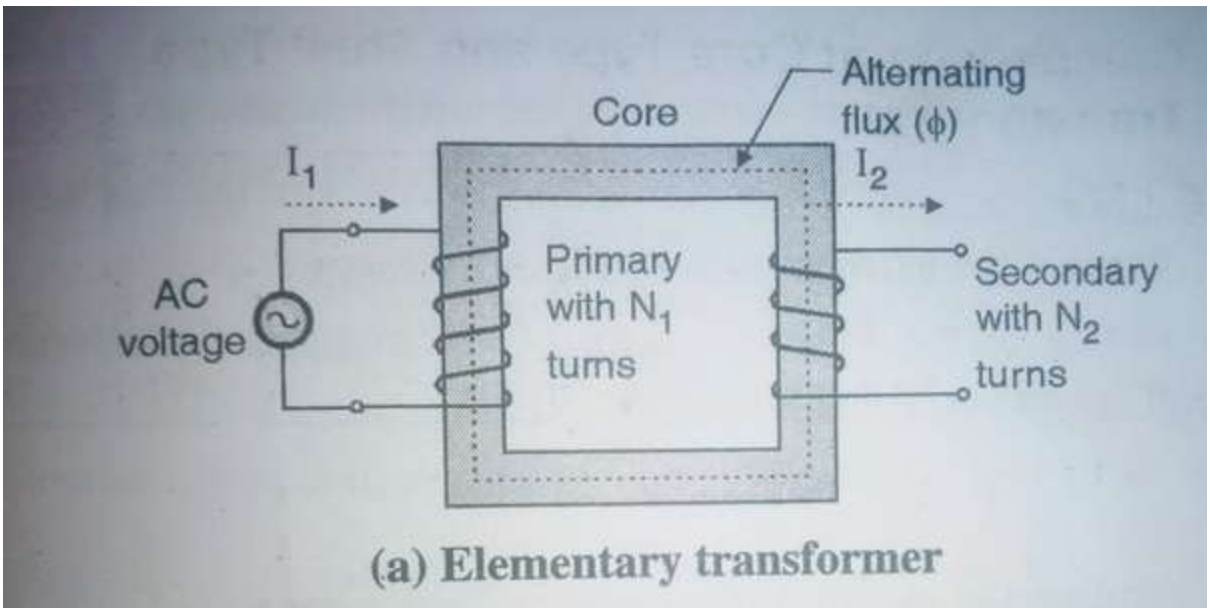
EMF EQUATION of a TRANSFORMER

Consider that an alternating voltage V1 of frequency f is applied to the primary as shown in Fig. The sinusoidal flux Φ produced by the primary can be represented as



(a) Elementary transformer

$$E_1 = \frac{E_{max}}{\sqrt{2}} = \frac{2\pi f N_1 \phi_m}{\sqrt{2}}$$

or $$E_1 = 4.44 f N_1 \phi_m$$

Similarly $$E_2 = 4.44 f N_2 \phi_m$$

In an ideal transformer **E1=V1, E2=V2**

Voltage Transformation Ratio (K)

$$\frac{E_1}{N_1} = \frac{E_2}{N_2} = k$$

$$K = \frac{E_2}{E_1} = \frac{N_2}{N_1}$$

$$K = \frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{I_1}{I_2} \qquad Ideal\ transformer$$

Exp 1: A single-phase transformer has 480 turns on the primary winding and 90 turns on the secondary winding. The maximum value of the magnetic flux density is 1.1T when 2200 volts, 50Hz is applied to the transformer primary winding. Calculate:

a). The maximum flux in the core.

E1 = 4.44 f Φm N1

2200 =4.44 *50 *Φm *480

Φm = 2200/(4.44*50*480) = 0.0206 Wb or 20.6 mWb

b). The cross-sectional area of the core

Φm = Bm × A

A = Φm / Bm = 0.0206/1.1= 0.0187 m2

c). The secondary induced emf.

$$\frac{V1}{V2} = \frac{N1}{N2}$$

V2* N1 = V1* N2

V2= V1 $\frac{N2}{N1}$

(2200) * (90/480) = 412.5 V

Exp 2.

A 60 kVA, 1600 V/100 V, 50 Hz, single-phase transformer has 50 secondary windings. Calculate (a) the primary and secondary current, (b) the number of primary turns and (c) the maximum value of the flux

V1= 1600V = , V2= 100V = , f = 50 Hz, N2= 50 turns

(a) Transformer rating S= V1* I1= V2* I2= 60000VA

hence, primary current, I1=$\frac{60000}{1600}$**= 37.5A**

I2= $\frac{60000}{100}$**=600 A**

$$\frac{V1}{V2} = \frac{N1}{N2}$$

V2* N1 = V1* N2

N1=$\frac{V1*N2}{V2}$**=**$\frac{1600*50}{100}$**= 800 turns**

E2=4.44 f Φm N2

Φm=$\frac{E2}{4.44*50*50}$ **=9.0 mWb**

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Q1:

A single-phase, 50 Hz transformer has 40 primary turns and 520 secondary turns. The cross-sectional area of the core is 270 cm2 . When the primary winding is connected to a 300-volt supply, determine (a) the maximum value of flux density in the core, and (b) the voltage induced in the secondary winding

Ans:

(a) 1.25 T

(b) V2 = 3900 V

Q2:

A single-phase 800 V/100 V, 50 Hz transformer has a maximum core flux density of 1.294 T and an effective cross-sectional area of 60 2 cm . Calculate the number of turns on the primary and secondary windings.

Ans:

N_1 = 464 turns

N_2 = 58 turns

Q3:

A 3.3 kV/110 V, 50 Hz, single-phase transformer is to have an approximate e.m.f. per turn of 22 V and operate with a maximum flux of 1.25 T. Calculate (a) the number of primary and secondary turns, and (b) the crosssectional area of the core

Ans:

a

N_1= 150

N_2= 5

B

= 0.07928 m^2