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FACULTY OF ENGINEERING & TECHNOLOGY

Electrical Machine-1

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The Equivalent Circuit of a Transformer

The losses that occur in transformers have to be accounted for in any accurate model of transformer behavior.

1. *Copper (I^2R) losses*. Copper losses are the resistive heating losses in the primary and secondary windings of the transformer. They are proportional to the square of the current in the windings.

2. *Eddy current losses*. Eddy current losses are resistive heating losses in the core of the transformer. They are proportional to the square of the voltage applied to the transformer.

3. *Hysteresis losses*. Hysteresis losses are associated with the rearrangement of the magnetic domains in the core during each half-cycle. They are a complex, nonlinear function of the voltage applied to the transformer.

4. *Leakage flux*. The fluxes which escape the core and pass through only one of the transformer windings are leakage fluxes. These escaped fluxes produce a self-inductance in the primary and secondary coils, and the effects of this inductance must be accounted for.

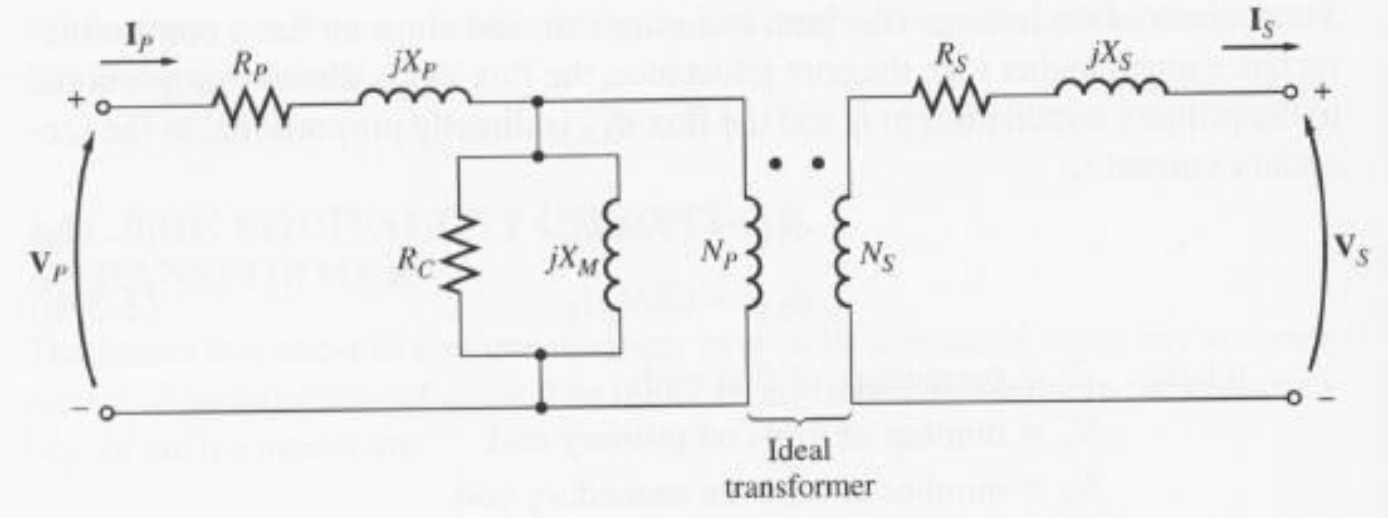
The Exact Equivalent Circuit of a Transformer

Modeling the copper losses: resistive losses in the primary and secondary windings of the core, represented in the equivalent circuit by R_P and R_S.

Modeling the leakage fluxes: primary leakage flux is proportional to the primary current I_P and secondary leakage flux is proportional to the secondary current I_S, represented in the equivalent circuit by X_P ($=f_{LP}/I_P$) and X_S ($=f_{LS}/I_S$).

Modeling the core excitation: I_m is proportional to the voltage applied to the core and lags the applied voltage by 90°. It is modeled by X_M.

Modeling the core loss current: I_{h+e} is proportional to the voltage applied to the core and in phase with the applied voltage. It is modeled by R_C.



Approximate Equivalent Circuits of a Transformer

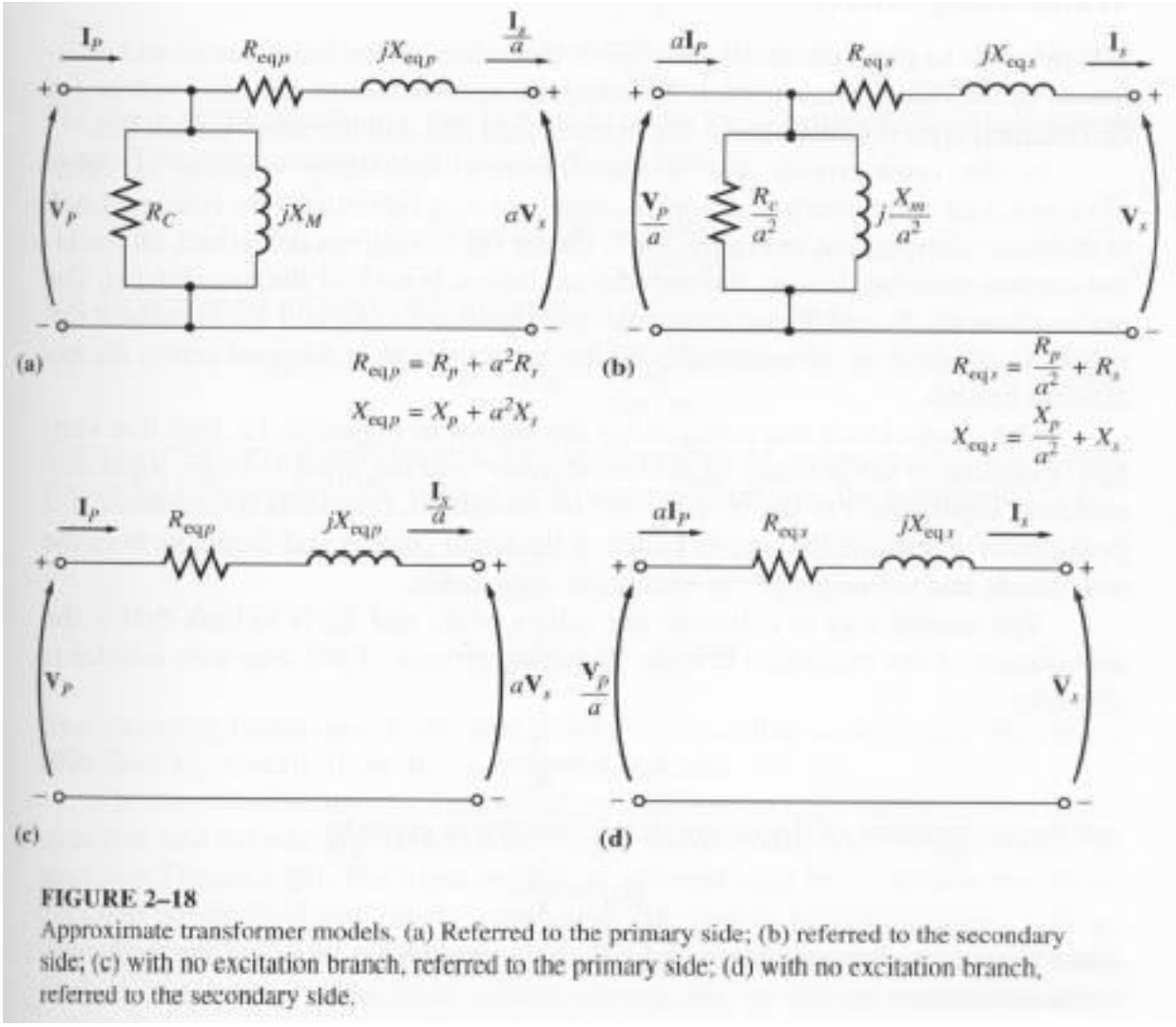


FIGURE 2–18
Approximate transformer models. (a) Referred to the primary side; (b) referred to the secondary side; (c) with no excitation branch, referred to the primary side; (d) with no excitation branch, referred to the secondary side.