Electrical Machines Laboratory

Department of Electrical Engineering, IIT Kharagpur

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Experiment #1

A. Study of Scott Connected Transformers

Objectives

- To obtain balanced two-phase supply from three-phase supply by Scott connection of two transformers.
- To study the voltage and current waveforms for different balanced and unbalanced loads.

Procedure

1. Use the transformer model provided to the respective batches before the start of the experiment.
2. Connect the circuit in MATLAB/Simulink as shown in Fig. 1. (Please ensure that the components used are under the Simulink library → Simscape → Electrical → Specialized Power Systems → Fundamental Blocks).
3. To measure the various voltages and currents, use the "Voltage Measurement" and "Current Measurement" blocks respectively. For a three-phase system, you may use the "Three-Phase V-I Measurement" block.
4. Start with a balanced load, and observe all the relevant waveforms.
5. Repeat the previous part with different combinations of balanced and unbalanced load.

Example

The Scott connection is used to link two- and three-phase supply systems, with power flow in either direction. As shown in Fig 1, a Scott-connected transformer is fed from a 220 V,

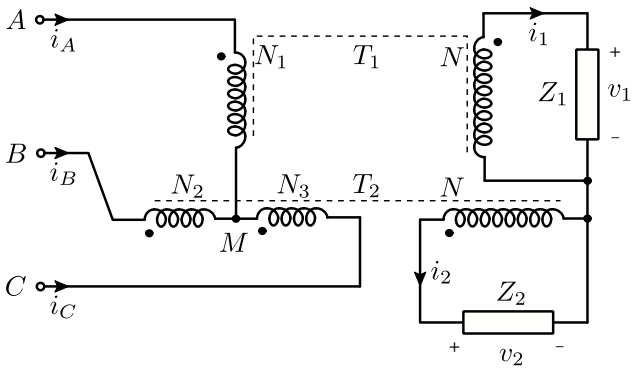

Figure 1. Schematic of the Scott connection of transformers.

50 Hz, three-phase AC network, and supplies a two-phase load with a rated power of 5 kW, and rated phase voltage of 220 V. The transformers are ideal, with the specifications being

T1: $N_1 : N = \sqrt{3} : 2$.

T2: $N_2 : N_3 : N = 1 : 1 : 2$.

The relevant steady-state waveforms, with two-phase balanced and unbalanced load is shown in Fig 2(a-b). Note that the voltage $\overline{V_2}$ lags the voltage $\overline{V_1}$ by 90° irrespective of the load. For a balanced two-phase load, the current drawn from the three-phase supply is balanced (see Fig 2(a)).

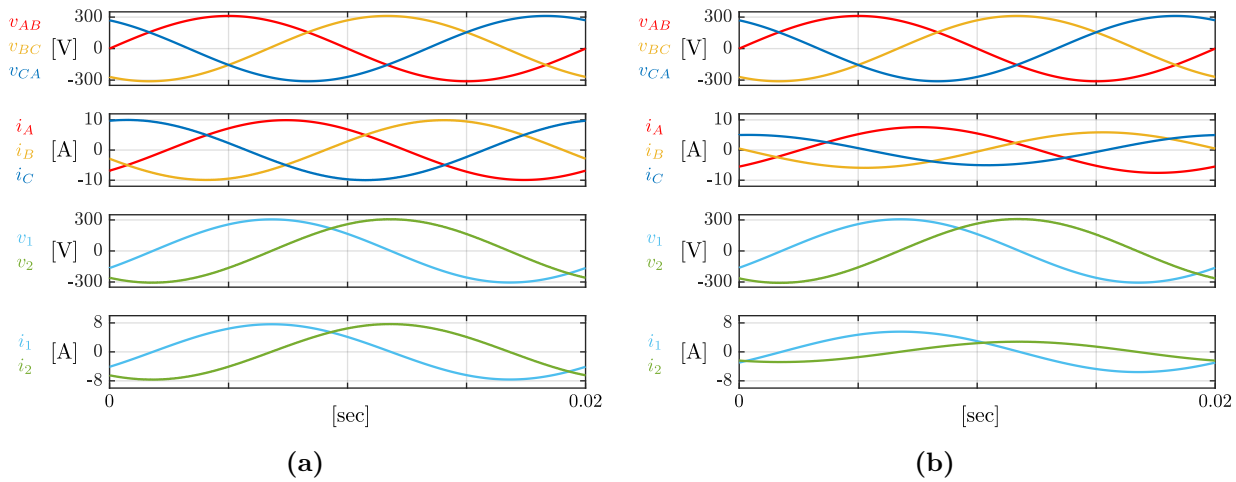

Figure 2. Steady-state waveform for a Scott-connected transformer supplying a two-phase load from a three-phase source (a) Balanced two-phase load with $Z_1 = Z_2 = 40\,\Omega$. (b) Unbalanced two-phase load with $Z_1 = 55\,\Omega$ and $Z_2 = 110\,\Omega$.

B. Study of Vector Group of Transformers

Objectives

- To connect three single-phase transformers in (a) star/star, (b) star/delta, (c) delta/star, (d) delta/delta, (e) star/zigzag, (f) delta/zigzag, and to obtain the no-load line voltage ratios and phase relations for each connection.
- To study the voltage and/or current waveforms for different connections.

Procedure

1. Use the transformer model provided to the respective batches before the start of the experiment.
2. Connect the circuit in MATLAB/Simulink as per the instruction sheet.
3. To measure the various voltages and currents, use the "Voltage Measurement" and "Current Measurement" blocks respectively. For a three-phase system, you may use the "Three-Phase V-I Measurement" block.
4. Observe the primary and secondary side line voltages for different transformer connections.

Example

The windings of a three-phase transformer can be connected in several configurations, namely star, delta, and zig-zag. Based on the connection, a line voltage on the secondary side has a phase relation with the corresponding primary line voltage. Fig 3 shows three such combinations. Here, three identical single-phase transformers of rating 220/110 V, 50 Hz, 1.5 kVA are used to obtain a three-phase transformer, and is fed from a 220 V, 50 Hz, three-phase supply. The primary line voltage v_{AB}, and the corresponding secondary line voltage v_{ab} is shown in Fig 4 (for the transformer connections $Yy6$, $Dd0$, and $Yd11$).

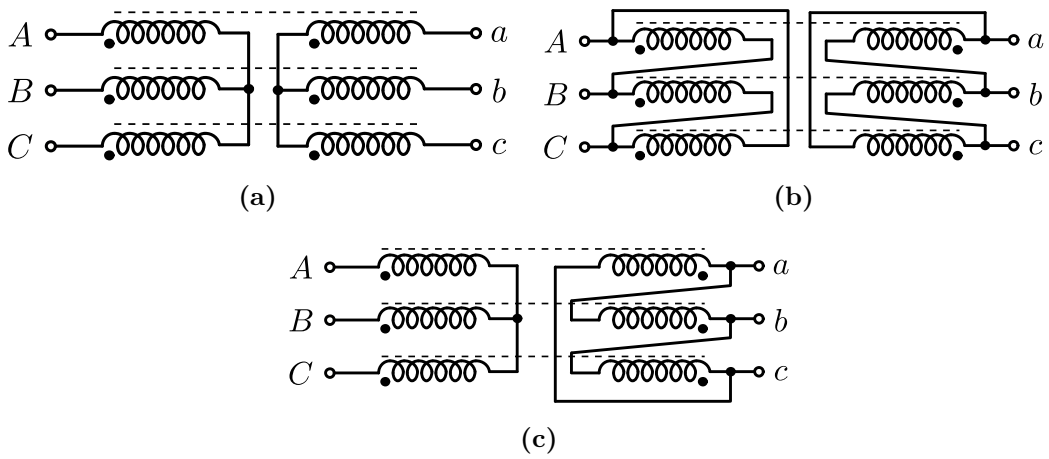

Figure 3. Three phase transformer connections (a) $Yy6$ (b) $Dd0$ (c) $Yd11$.

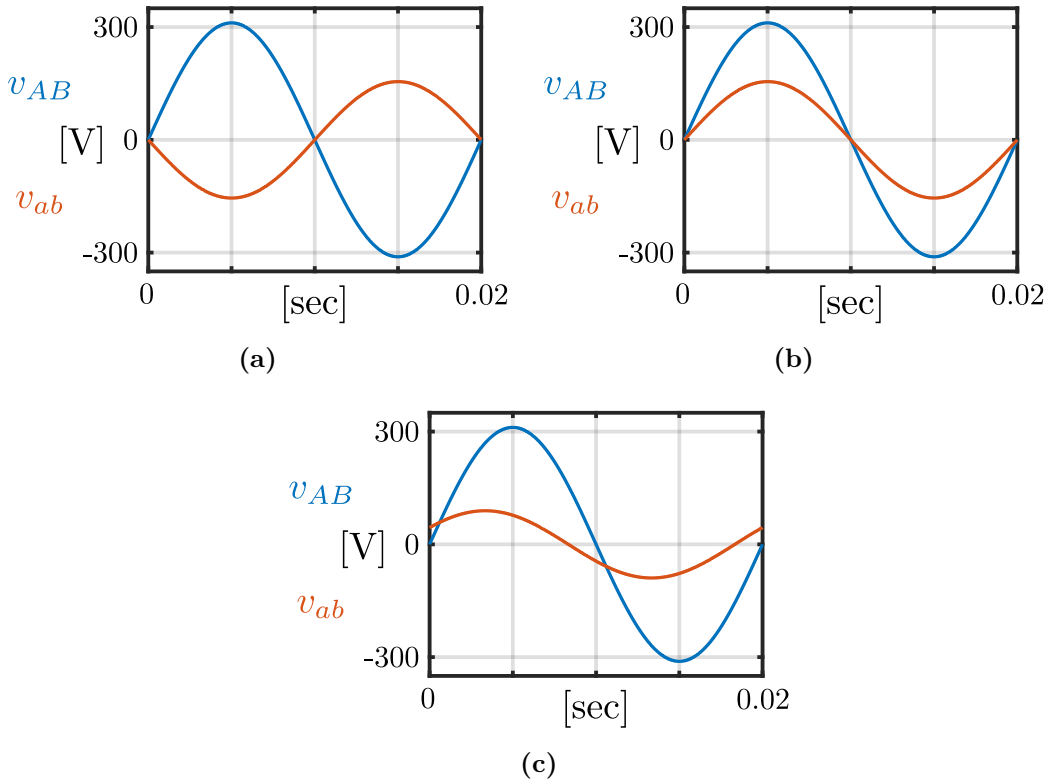

Figure 4. Primary side line voltage v_{AB} and the secondary side line voltage v_{ab} for different transformer connections (a) $Yy6$ (b) $Dd0$ (c) $Yd11$.