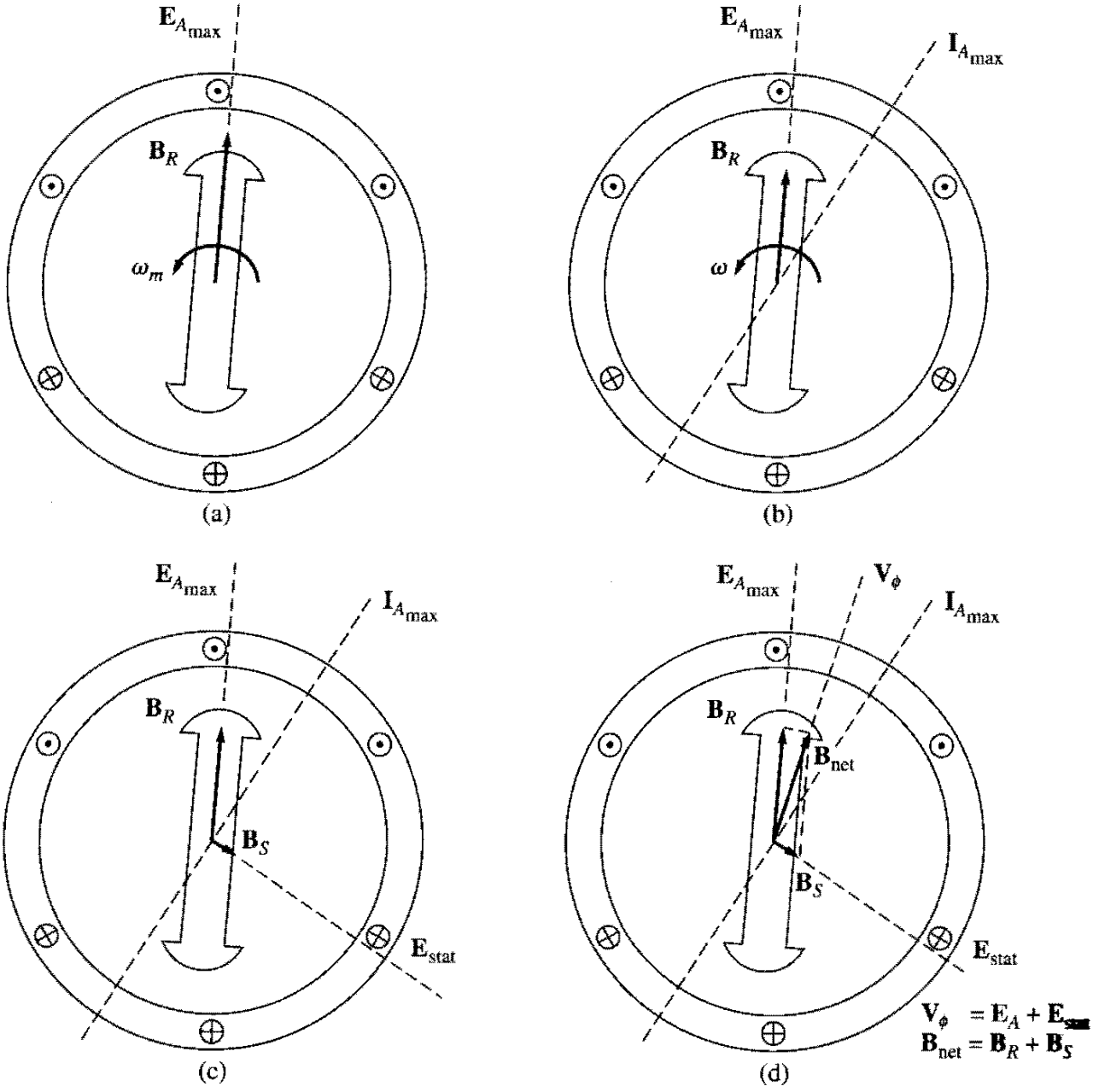
Armature Reaction for Synchronous Generators

Consider the simple three-phase 2-pole stator shown in Figure 5-8 of text.

Figure 5–8 The development of a model for armature reaction: (a) A rotating magnetic field produces the internal generated voltage $\mathbf{E}_A$. (b) The resulting voltage produces a lagging *current flow* when connected to a lagging load. (c) The stator current produces its own magnetic field $\mathbf{B}_S$, which produces its own voltage $\mathbf{E}_{stat}$ in the stator windings of the machine. (d) The field $\mathbf{B}_S$ adds to $\mathbf{B}_R$, distorting it into $\mathbf{B}_{net}$. The voltage $\mathbf{E}_{stat}$ adds to $\mathbf{E}_A$, producing $\mathbf{V}_\phi$ at the output of the phase.



a) No load on armature (stator) windings, i.e., $\overline{I}_A = 0$. Induced voltage on armature $\overline{E}_A$ aligned with rotor rotating magnetic flux density $\overline{B}_R$ is the same as the phase voltage $\overline{V}_\phi$.

b) Lagging load produces a current $\overline{I}_A$ on the armature (stator) windings that lags $\overline{E}_A$.

c) The armature current $\overline{I}_A$ through the stator windings generates a magnetic flux density $\overline{B}_S$ that is smaller than $\overline{B}_R$. Note direction of $\overline{B}_S$ is orthogonal to $\overline{I}_A$. This magnetic flux density $\overline{B}_S$ in turn induces a voltage $\overline{E}_{\text{stator}}$ on the stator.

d) The net magnetic flux density is the sum of the rotor and stator fields, i.e., $\overline{B}_{\text{net}} = \overline{B}_R + \overline{B}_S$ (net flux density lags $\overline{B}_R$). The net phase voltage is the sum of $\overline{E}_A$ (rotor) and $\overline{E}_{\text{stator}}$ (stator), i.e., $\overline{V}_\phi = \overline{E}_A + \overline{E}_{\text{stator}}$ (phase voltage lags $\overline{E}_A$).