Chapter 3 dealt with the relationship between the power available from the engine and the power requirement arising from driving resistance. The torque/speed profile of the internal combustion engine is not suited to use in motor vehicles (see also Section 2.3.2 “Why do Vehicles Need Gearboxes?”). Output converters are needed for the final output to approximate as closely as possible to the ideal engine characteristic with $P_{\text{max}} = \text{const}$ over the entire engine speed range. Clutches serve to adapt engine speed, transmissions serve to adapt both speed and torque. The conversion ratio is determined by theoretical and practical engineering constraints, which depend in many cases on the application.

The basic design of the transmission involves first determining the maximum and minimum ratio, i.e. the “overall gear ratio” of the transmission, and then selecting the intermediate ratios. Chapters 4 and 5 deal with the selection of these key features. They are the basis for the calculation, engineering and design of components (Figure 4.1).
4.1 Powertrain

In vehicles with internal combustion engines, the output conversion between the engine and the drive wheels is achieved by the combined action of the assemblies of the powertrain. Figure 4.2 shows the hierarchical structure of the various ratios in the powertrain, starting from the total powertrain ratio \( i_A \). The total ratio of the powertrain is derived from the ratio \( i_S \) of the moving-off element, the ratio \( i_G \) of the transmission and the final ratio \( i_E \),

\[
i_A = i_S \cdot i_G \cdot i_E. \tag{4.1}
\]

The ratio of output speed \( n_2 \) to input speed \( n_1 \) of a powertrain component is defined as speed conversion \( \nu \),

\[
\nu = \frac{n_2}{n_1}. \tag{4.2}
\]

The torque conversion \( \mu \) represents the ratio between the output torque \( T_2 \) and the input torque \( T_1 \) of a powertrain component,

\[
\mu = \frac{T_2}{T_1}. \tag{4.3}
\]

Fig. 4.2. Hierarchical structure of the powertrain ratio \( i_A \) using the example of a commercial vehicle with standard drive, i.e. front-mounted engine with rear-wheel drive