1. Determine the speed range required to give a frequency range $20 < f < 150$
2. Determine the corresponding range of open-circuit rotor potential difference.
3. Regard the machine as ideal, and determine the relative magnitudes of the power supplied ($+ve$) or absorbed ($-ve$) at both limits of the frequency range by
   (a) the stator source,
   (b) the driving machine,
   (c) the rotor circuit.

[Answer: 3a $800 \leq n \leq -1800$ rpm; 3b $73.3 \leq V_t \leq 550$ V]

2. A 4-pole, 3-phase, wound-rotor induction motor has the following per-phase equivalent-circuit parameters:

$$
\begin{aligned}
\text{Stator winding resistance } R_s &= 0.260\ \Omega \\
\text{Rotor winding resistance } R_r &= 0.182\ \Omega \\
\text{Stator leakage inductance } L_{ls} &= 1.06 \text{ mH} \\
\text{Rotor leakage inductance } L_{lr} &= 0.803 \text{ mH} \\
\text{Magnetizing inductance } L_{ms} &= 19.9 \text{ mH} \\
\text{Effective turns ratio } N_{se}/N_{re} &= 1.15
\end{aligned}
$$

The machine is to be employed as a frequency converter and for this purpose is mechanically coupled to an 8-pole, 60-Hz, synchronous motor. The set is then driven by the synchronous motor, and the stator terminals of the induction machine are connected to a 3-phase, 60-Hz source of 220 V line-to-line.

A 3-phase, wye-connected load, with a resistance of 5Ω and an inductance of 7 mH per phase, is then connected to the rotor terminals. Assume that the set is running in the direction that gives the higher of the two possible rotor frequencies, and determine the current in the load circuit.

[Answer: 21.6 A]

3. Given the frequency-conversion system of question 2, for the two possible frequencies, determine:

1. The three-phase active power delivered to the load circuit.
2. The three-phase active power input to the induction motor terminals,
3. The power output of the synchronous motor.

Rotational losses of the induction machine may be neglected.

[Answer: 1 6.97 kW, 1.03 kW; 2 5.55 kW, 3.11 kW; 3 2.41 kW, -1.75 kW]