1. Trip: $175 - 200\%$ of $Z_{\text{line}}$ [$175.8 - 201 @ 84.3^\circ$]
   Block: $125 - 160\%$ of $(Z_{\text{trip}} - Z_{\text{line}})$ – in other words, block MUST over-reach the trip

2. (a) 46 measures the negative sequence component of the stator current; the negative sequence induces a double frequency component in the rotor which will cause over-heating of the rotor.
   
   (b) $R = \frac{24000/\sqrt{3}}{(14400/240)^2 \times 10} = 0.3849$

3. (a) 86 is a lockout relay; when certain relays operate which indicate internal equipment faults, DO NOT permit reclosing until inspection and corrective action related to the faulty equipment is taken by personnel and the decision to recluse is made.
   (b) If a fault occurs on the transmission line, which is the communication line also, then the fault will block, or significantly attenuate, the tripping signal and then tripping would not occur.

4. (a) Dir. Comp. Block – the middle ckt; requires “permission” from the remote terminal, therefore the local 21 and the signal from the remote end (Dev. 85) must be in series.
   (b) Over-reach TT – the right most ckt; with over-reaching scheme, “permission” from the remote end required before tripping can occur, thus the contacts in series.
   (c) Under-reach TT -- the left most ckt.; for under-reaching “permission” not required from remote end, thus local relay (Dev. 21) can trip directly; remote –end can trip directly the CB

5. (a) With transformers the two currents are at different levels due to turns ratio of transformer; and for a delta-wye transformer, there is also a normal $30^\circ$ phase shift for balanced line currents which must be compensated for, otherwise would appear as an imbalance and operate the relay.
   (b) Pilot schemes DO NOT provide back-up protection; they provide “fast” detection/tripping for faults on 100% of line; they are CLOSED zones of protection, not open zones.

6. (a) only schemes 1 [50 & 51] & 2 [3 step zone distance] provide remote back-up;
   (b) only dir. comp. block provides high speed protection for 100% of line length;
   (c) distance protection & dir. comp. block not affected by source impedance;
   (d) least expensive is 50/51 scheme, simpler relays and least peripheral equipment; most expensive dir. Comp. block, most expensive relays and most peripheral equipment, such as transmitter/receiver, wave traps, & CCPD.