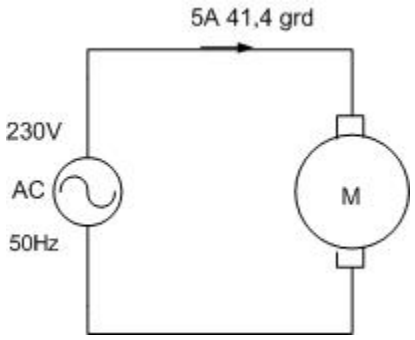
Uitwerking ET3026WB 23-6-10

Problem 1

$\cos\varphi = 0,75 \Rightarrow \varphi = 41,4^o$



a) $Q = U \times I \times \sin 41,4 = 760,6VAr$

b) $P = U \times I \times \cos 41,4 = 862,6W$

c) new cosφ=0,9 $\cos\varphi$=0,9 $\Rightarrow \varphi$=25,84°

New apparent power; $S_N = \frac{P}{\cos\varphi} = \frac{862,6}{0,9} = 958,44VA$

New reactive power: $Q_N = \sqrt{S_N{}^2 - P^2} = \sqrt{958,44^2 - 862,6^2} = 417,76VAr$

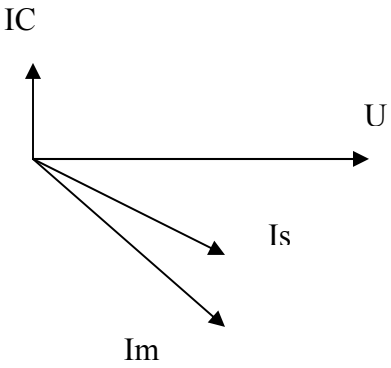
Reactive power supplied by capacitor: $Q_C = Q - Q_N = 760,6 - 417,76 = 342,84VAr$

$$X_C = \frac{U}{Q_C} = \frac{230}{342,84} = 154,3\Omega$$

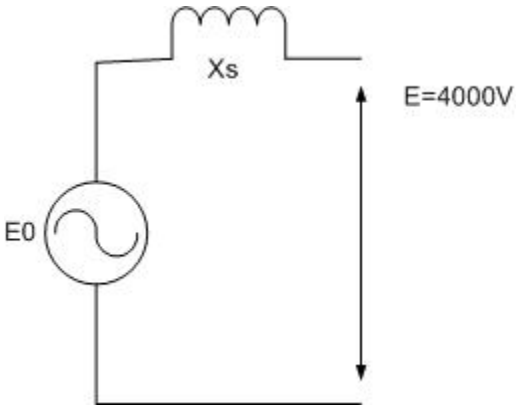
$I_C = \frac{U}{X_C} = \frac{230}{154,3} = 1,49A$

$\frac{1}{C} = 2 \times \pi \times 50 \times 154,3 \Rightarrow C = 20,6\mu F$

d)



Problem 2
Example 16.2
a) Draw the per phase equivalent circuit in the open-circuit situation including the line-to neutral voltage. *(2 points)*



$$U_{L1N} = \frac{6928}{\sqrt{3}} = 4000V$$

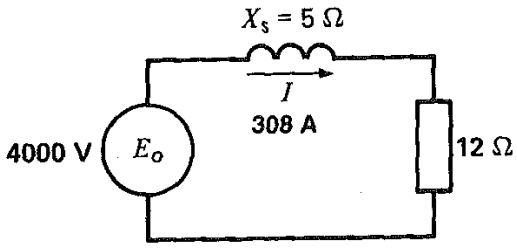
b) Calculate the synchronous reactance per phase. *(3 points).*

When the terminals are short-circuited, the only impedance limiting the current flow is that due to the synchronous reactance. Consequently,

$$X_s = E_o/I = 4000/800$$
$$= 5\ \Omega$$

The synchronous reactance per phase is therefore 5 Ω.

c) Calculate the terminal voltage (line to neutral) if three 12Ω resistors are connected in wye across the terminals. *(3 points)*
Per phase equivalent.



The impedance of the circuit is

$$Z = \sqrt{R^2 + X_s^2}$$
$$= \sqrt{12^2 + 5^2}$$
$$= 13\ \Omega$$

The current is

$$I = E_o/Z = 4000/13 = 308\ \text{A}$$

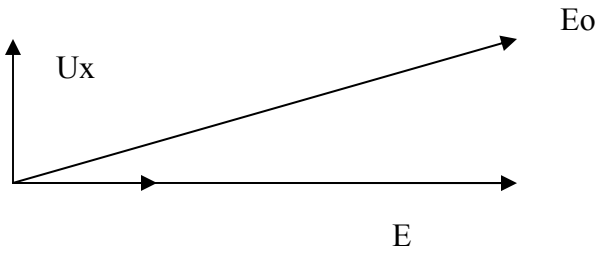
The voltage across the load resistor is

$$E = IR = 308 \times 12 = 3696\ \text{V}$$

The line voltage under load is

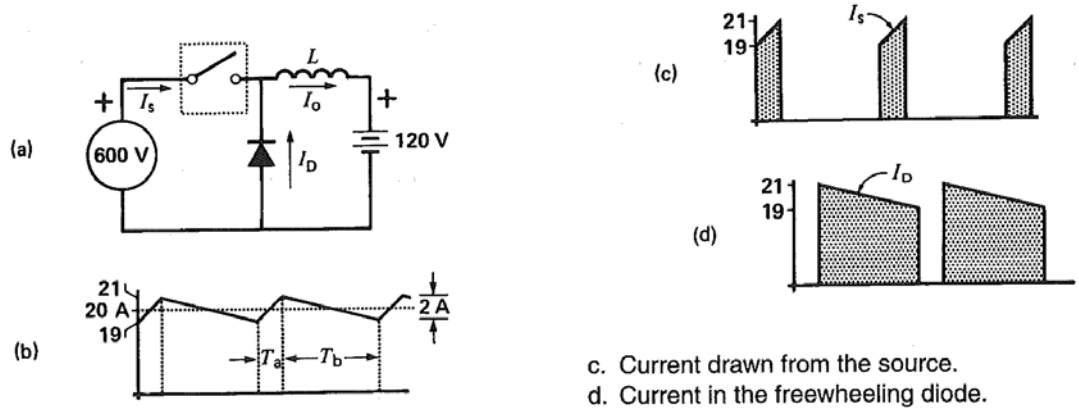
$$E_L = \sqrt{3}\,E$$
$$= \sqrt{3} \times 3696$$
$$= 6402\ \text{V}$$

d) Draw the fasor diagram with the voltages and the current of situation c). *(2 points)*



Problem 3
Example 21-11
a) The current drawn from the source.(2 points)
The power supplied to the battery is: $P = 120 \cdot 20 = 2400W$
The current from the source is: $I_s = \frac{P}{E_s} = \frac{2400}{600} = 4A$
b) The current in the diode. (2 points)

To calculate the average current in the diode, we refer to fig 21.61a. Current Io=20A and Is was found to be 4A. Applying Kirchoff's current law to the diode/inductor junction, the average diode current Id is: $I_D = I_o - I_s = 20 - 4 = 16A$



c. Current drawn from the source.
d. Current in the freewheeling diode.

Figure 21.61
a. Circuit of Example 21-11.
b. Current in the load.

c) The duty cycle. (3 points)
The duty cycle is: $D = \frac{E_o}{E_s} = \frac{120}{600} = 0,2$
d) The inductance of the inductor. (3 points)

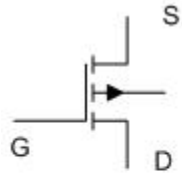
d. During interval T_a the average voltage across the inductor is (600 − 120) = 480 V. The volt-seconds accumulated by the inductor during this interval is $A_{(+)}$ = 480 V × 1 ms = 480 mV·s = 0.48 V·s. The change in current during the interval is 2 A; consequently,

$$\Delta I = A_{(+)}/L \qquad (2.28)$$

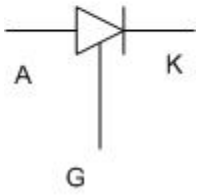
$$2 = 0.48/L$$

$$L = 0.24 \text{ H}$$

1. *(1 point)*
Draw the symbol and state the typical properties of a thyristor and MOSFET.

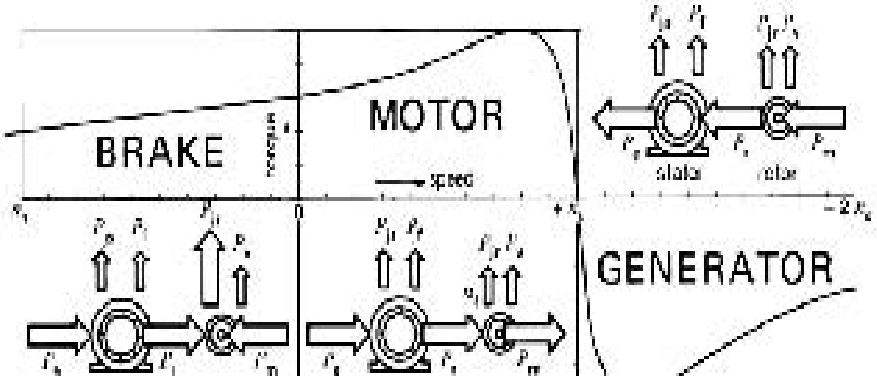


Mosfet: High switching frequency, 200kHz. Max current approx 100A, voltage 1kV.

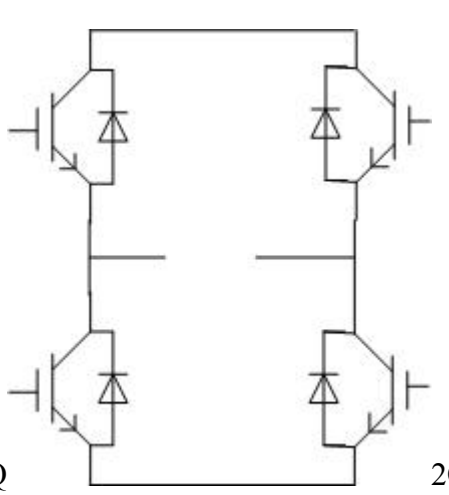


Thyristor: max switching frequency, 3kHz. Max current 3kA. Max voltage 4kV

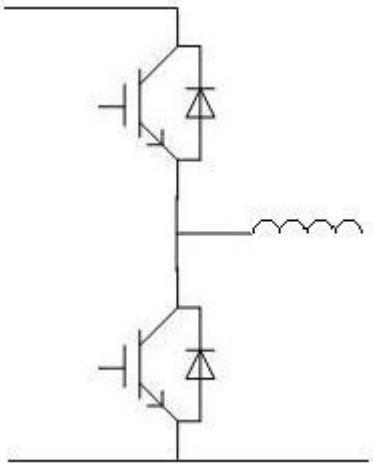
2. *(2 point)*
Draw the complete torque speed curve of a 3 phase induction machine and mark the brake + motor and generator region.



3. *(2 points)*
Draw the schematic of a two quadrant and a four quadrant electronic DC-DC converter with the use of IGBT switches and diodes.



4Q



2Q

4. *(3 points)* Simple battery charger.
Draw the voltage between point 2 and 1, 3 and 1 and 4 and 1 and current I of the circuit from fig. 21.11

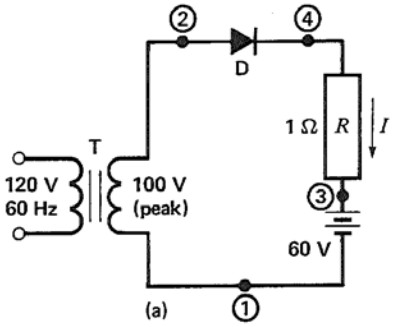


Figure 21.11
a. Simple battery charger circuit.

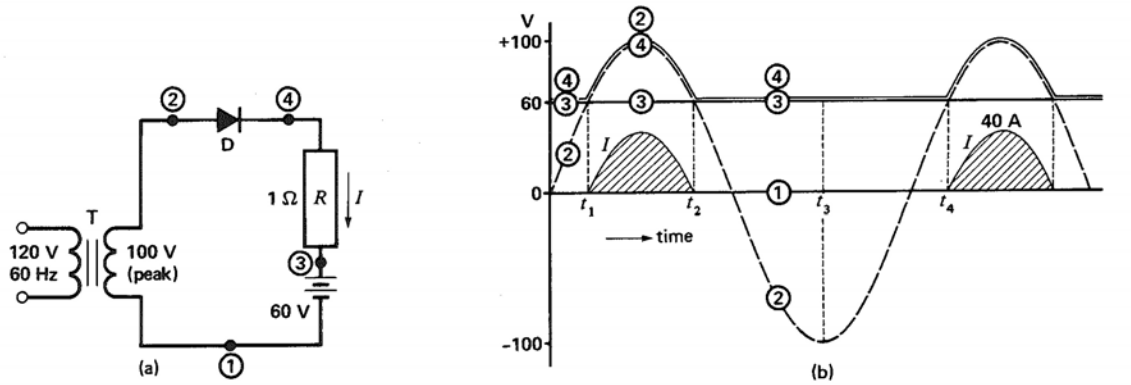
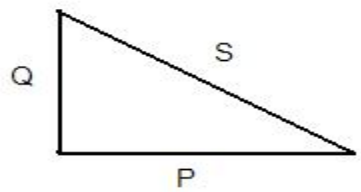


Figure 21.11
a. Simple battery charger circuit.
b. Corresponding voltage and current waveforms.

5. *(1 point)*
What is the definition of "power factor" PF?

5) (1 point) $pf = \frac{P}{S}$, power factor is de cos van de hoek tussen spanning en stroom. En



6. *(1 point)*
Explain the meaning of the following terms.
1) Anode 2) Cathode 3)Inverter
Anode: positive pole. Cathode: negative pole. Inverter: e.g Dc to AC