Chapter 5.8

Q1 (a) From $\frac{V_P}{V_S}=\frac{N_P}{N_S}$ we get $\frac{220}{V_S}=\frac{500}{200}\Rightarrow V_S=\frac{200\times 220}{500}=88\text{ V}$. The frequency is unchanged so it stays 50 Hz. (b) The power in the primary is $P=V_PI_P=220\times 6.0=1320\text{ W}$ and so that in the secondary is $0.70\times 1320=924\text{ W}$. Hence the current is $\frac{924}{88}=10.5\text{ A}$.

Q2 (a) The current produced is $I=\frac{P}{V}=\frac{300\times 10^6}{80\times 10^3}=3750\text{ A}$. The power lost in the cables is then $5.0\times 3750^2=7.0\times 10^7\text{ W}$, a fraction $\frac{7.0\times 10^7}{300\times 10^6}=0.23$ of the power produced. (b) At 100 kV, the current is $I=\frac{P}{V}=\frac{300\times 10^6}{100\times 10^3}=3000\text{ A}$ and the power lost is $5.0\times 3000^2=4.5\times 10^7\text{ W}$ representing a smaller fraction $\frac{4.5\times 10^7}{300\times 10^6}=0.15$ of the total power produced.

Q3 The r.m.s. voltage is given by $V_{rms}=\frac{\omega NBA}{\sqrt{2}}$ and $\omega=2\pi f=100\pi\text{ s}^{-1}$. Hence $B=\frac{V_{rms}\sqrt{2}}{\omega NA}=\frac{220\sqrt{2}}{100\pi\times 300\times 0.20^2}=0.0825\text{ T}$.

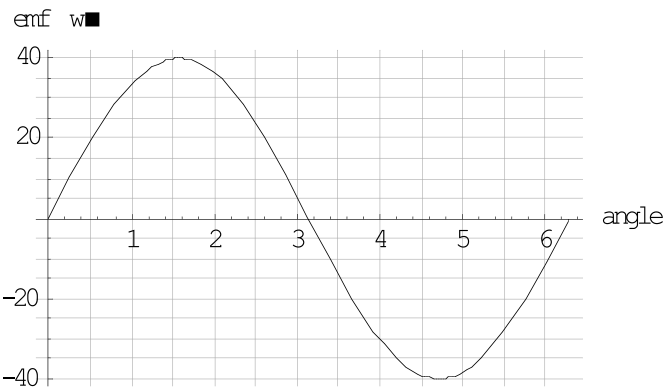
Q4 The answer can be obtained by finding the maximum slope of the flux graph (for example at 0.45 ms and then dividing by $\sqrt{2}$. Alternatively, the formula for flux is $\phi=10\cos(\frac{2\pi t}{0.9\times 10^{-3}})$ and so the formula for induced emf is $emf=-10\times\frac{2\pi}{0.9\times 10^{-3}}\sin(\frac{2\pi t}{0.9\times 10^{-3}})$ so that the peak emf is $emf=10\times\frac{2\pi}{0.9\times 10^{-3}}=69.8\text{ kV}$. The r.m.s. voltage is then $\frac{69.8}{\sqrt{2}}=49\text{ kV}$.

Q5 (a) The current produced is $I=\frac{P}{V}=\frac{150\times 10^3}{1.0\times 10^3}=150\text{ A}$. The power lost in the cables is then $2.0\times 150^2=4.5\times 10^4\text{ W}$, a fraction $\frac{4.5\times 10^4}{150\times 10^3}=0.30$ of the power produced. (b) At 5000 V, the current is $I=\frac{P}{V}=\frac{150\times 10^3}{5.0\times 10^3}=30\text{ A}$ and the power lost is $2.0\times 30^2=1.8\times 10^3\text{ W}$ representing a smaller fraction $\frac{1.8\times 10^3}{150\times 10^3}=0.012$ of the total power produced.

Q6 It would be DC current, i.e. the electrons would move in the same direction but the current would not be constant.

Q7 (A) The peak power is 20 W and so the average power is 10 W. Hence $\overline{P} = RI^2_{rms} \Rightarrow I_{rms} = \sqrt{\frac{10}{2.5}} = 2.0\text{ A}$. (b) $R = \frac{V_{rms}}{I_{rms}} \Rightarrow V_{rms} = 2.0 \times 2.5 = 5.0\text{ V}$. (c) The period is 1.0 s (there are two peaks within one period). (d) At double the rotation speed the period will halve and the peak power will increase by a factor of 4 leading to the graph in the answers in the textbook. This is because at double the rotation speed the induced emf doubles and so the power (that depends on the square of the induced emf) increases by a factor of 4.

Q8 (a) The graph of emf versus angle is shown below. The vertical axis is actually the emf divided by the angular speed of rotation.



(b) There will no be change in the graph shown in Fig. 8.12 in the textbook.
(c) The new graph for emf (divided by angular speed) is shown below along with the original graph.