2. (5 marks)
On a particular generator in a bicycle, the rotating coil has 500 loops, each of area 2.50×10^{-4} m^2.
The magnetic field can be assumed to be uniform and of magnitude 0.400 T. When the bicycle is ridden at a particular speed the magnet rotates at 8.00 Hz.

a) What is the magnitude of the average induced emf at this speed? (3 marks**)** **ACCEPT BOTH IF STUDENTS ARE UNAWARE THAT A DYNAMO IS AN AC DEVICE**

$E = N \frac{\Delta \emptyset}{\Delta t}$

8 Hz represents a Δt of 0.03125 s (1 mark)

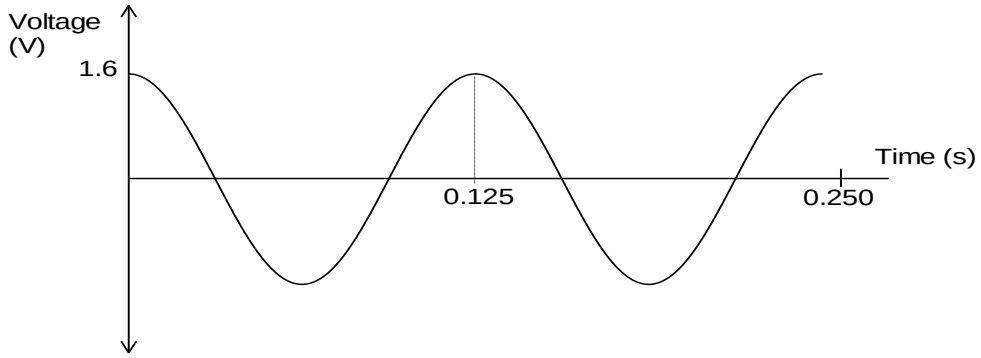
$$E = - \frac{500 \; x \; 0.4 \; x \; 2.50 \; x \; 10^{-4}}{0.03125} \qquad \text{(1 mark)}$$

E = 1.6 V (1 mark)

OR $E_{max} = 2\pi NBAf = 2\pi \times 500 \times 0.400 \times 2.50 \times 10^{-4} \times 8.00 = 2.51$ V (2 marks)

$E_{rms} = E_{max} / \sqrt{2} = 1.78$ V (1 mark)

b) Complete the following sketch graph of voltage against time for two complete rotations of the magnet starting from time, T = 0. You need to show the scale on the time axis only. (2 marks)



Two cycles (1 mark) Correct scale on time axis (1 mark)

If answer is 1.78 V, the graph should reflect that, however no marks to be deducted. Graph can start at 0 since orientation of the dynamo at T = 0 is not specified.

5. (14 marks)

a) Determine the average current flowing in the secondary coil of the substation transformer? (3 marks)

P = I x V

50 000 = I x 11 000 (2 marks)

I = 4.55 A (1 mark)

b) When energy is being delivered at 50 kW at the secondary coil of the substation transformer, the voltage at the primary coil of the pole transformers is 10.5 kV.

Calculate the power loss in the wires joining the substation transformer and street pole transformer? (3 marks)

Loss = I x V

4.55 x (11 – 10.5) x 10^3 (2 marks)

= 2.28 x 10^3 W (1 mark)

c) If there are 6.3 x 10^3 turns in the primary of the pole transformer, how many turns are in the secondary coil? What current flows in the secondary coil? Assume the transformer is ideal. (3 marks)

Ratio of voltages = $\frac{V_P}{V_S} = \frac{10500}{240}$ = 43.75 (1 mark)

$$\frac{V_P}{V_S} = \frac{N_P}{N_S}$$

$$\frac{6300}{N_S} = 43.75$$

$N_S = \frac{6300}{43.75}$ = 144 turns (1 mark)

$$\frac{Ns}{N_P} = \frac{I_P}{I_S}$$

$$\frac{144}{6300} = \frac{4.55}{I_S}$$

I_S = 199 A (1 mark)

d) Explain why AC is used in the primary coil of a transformer rather than DC? (2 marks)

Current is only induced when the magnetic flux changes in the conductor. (1 mark)

AC changes 50 times per second and so induces a sustained current in the secondary coil. (1 mark)

e) Explain why electricity is transmitted at high voltages between power stations and the cities where it is used. (3 marks)

Electricity is transmitted at high voltages to reduce the current. (1 mark)

Power loss is a function of current ($P = I^2 \times R$). (1 mark)

If the current is kept lower then the losses will be reduced. (1 mark)