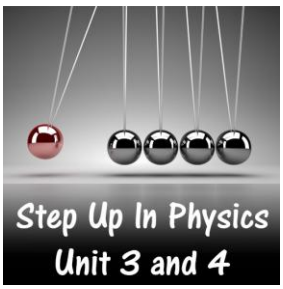
Transformers and Power Distribution

Problems Worksheet



1. A transformer has a 120 V AC potential difference applied to its input side which has 200 windings. The output side has 150 windings.
    a. Is the transformer step up or step down? Justify your choice.

    b. Calculate the output voltage of this transformer.

    c. Calculate the peak output voltage of this transformer.

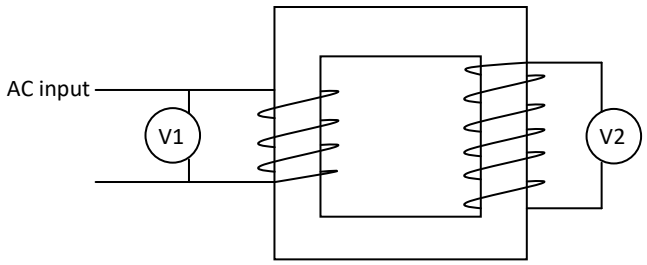
2. A transformer is made up of only a few basic components.
    a. Describe the purpose of the AC input in the primary windings.

    b. Describe the purpose of the soft iron core.

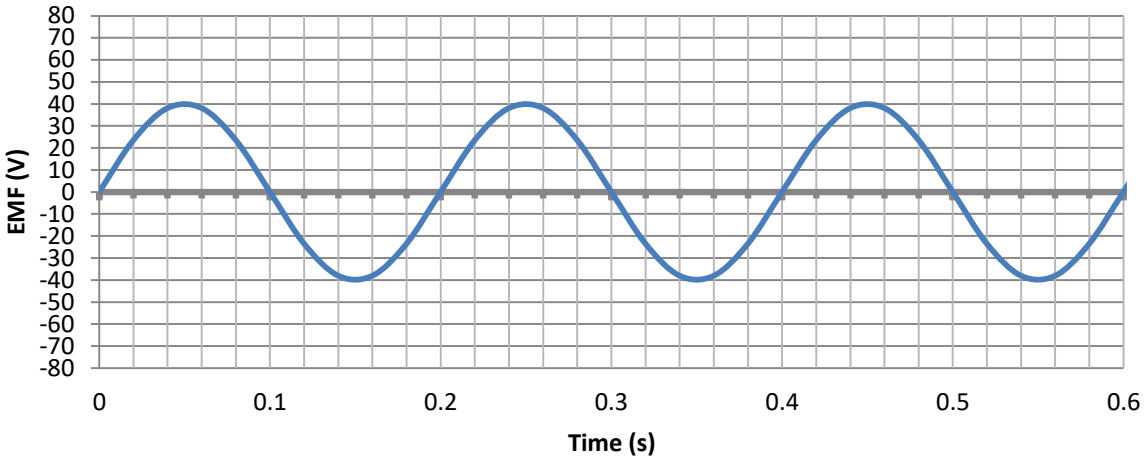
    c. Describe the purpose of the laminations in the core.

    d. Describe the purpose of the secondary windings.

3. Two voltemeters are used to monitor the inpupt and output voltages of a transformer, shown below.



The voltage as measured by the voltmeter across the primary windings (V1) as a function of time is shown below.



a. What is the frequency of the primary current?

b. Determine both the peak and rms values of the primary voltage.

c. There are 4 primary windings and 6 secondary windings. Calculate the peak and rms secondary voltage.

d. Over the top of the voltage profile of the primary windings given above, sketch the potential difference (V2) measured across the secondary windings along the same time scale.

4. A step down transformer that powers a 12.0 kW air conditioner is supplied with 500 V AC on its primary side. The air conditioner needs 240 V AC to operate. Assuming the transformer is 100% efficient;
    a. Calculate the rms current supplied to the primary side of the transformer.

    b. Calculate the rms current on the secondary side of the transformer.

    c. The transformer has 25 windings on its primary side. How many windings will it need on its secondary side?

    d. If the transformer was 95.0 % efficient, calculate the rms current in both the primary and secondary windings.

5. A transformer has 1200 windings on the primary side, 850 windings on the secondary side and is 97.0 % efficient. The transformer needs to supply 230 kW at 180 V to a transmission line.
    a. Calculate the maximum current in the primary windings.

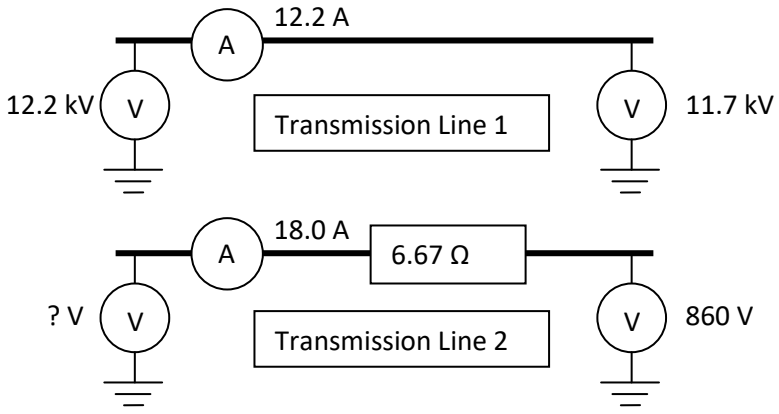
    b. Describe how the normal operation of the transformer could cause a 3.00 % loss of power.

6. A 1.80 Ω transmission line has 36.0 A current flowing through it and supplies a neighbourhood with a 240 V electrical supply.

    a. Calculate the power loss of the transmission line.

    b. Calculate the potential difference across the transmission line.

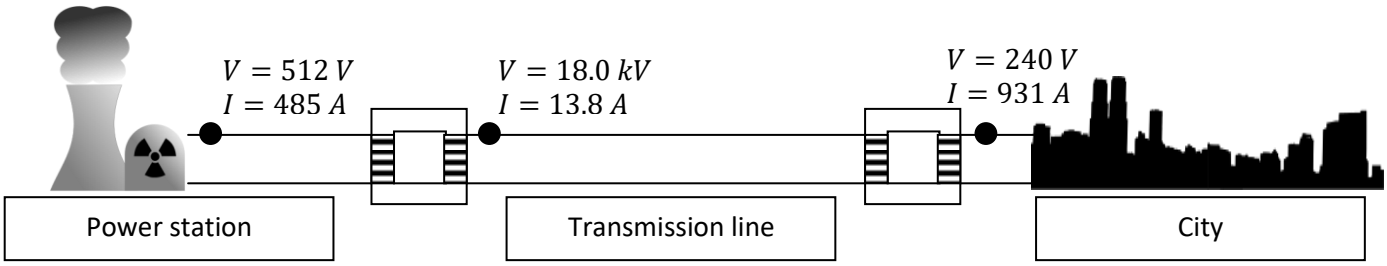
7. A power company was monitoring power losses across its network as stage one of a plan to prioritise the redesign of the lossy sections. Two transmission lines were narrowed down as possible candidates to be improved first.



The cost of improving each transmission line by 15% is the same. Which transmission line (1 or 2) would you recommend to be improved first? Justify your answer.

8. Explain why step up transformers are used on the supply provided by a power station responsible for producing the power for a city located 25.0 km away.

9. The diagram below shows a power distribution system, starting with the output of the generator at the power plant and ending with the consumption of power in the city. The voltage (with respect to the ground) and current readings at various stages of the network are shown in the diagram. Assume both transformers are ideal and the transmission line is the only source of significant resistance.



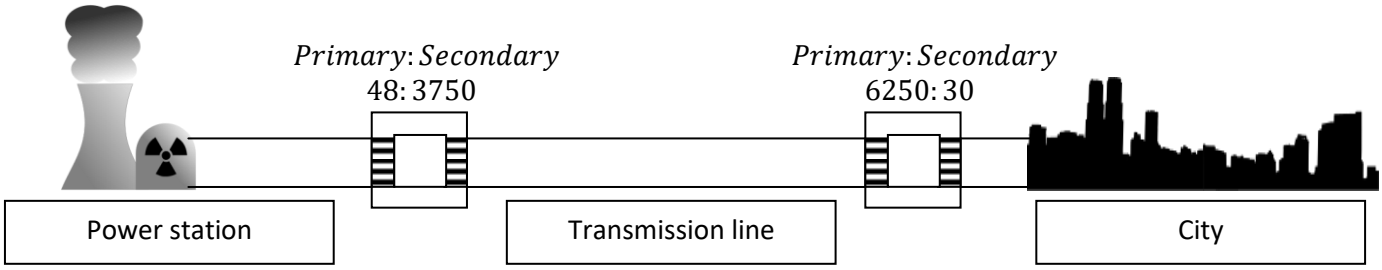
a. Is the transformer closest to the power station a step up or step down transformer? Justify your response.

b. Specify the ratio of primary windings to secondary windings for the transformer closest to the power station.

c. Calculate the power loss of the transmission line.

d. Calculate the resistance of the transmission line.

10. The power network below uses transformers that are 92.0 % efficient and the transmission line has 4.80 Ω resistance. The windings in each transformer are given in the diagram. The city requires 5.60 MW during peak usage and operates off a 240 V supply.



a. Calculate the current that supplies the city with power.

b. Calculate the power loss of the transmission line.

c. Calculate the potential difference of the transmission line

d. Calculate the voltage supplied by the power station to meet the peak load requirements of the city.