Multiple choice solutions

Example 1 2010 Question 18, 65%

The power supply was set to 20.8 $V_{RMS.}$ Therefore $V_P = 20.8 \times \sqrt{2}$

$= 29.4$ V,

$\therefore V_{P\ to\ P} = 29.4 \times 2$

$= 58.8$

∴ D (ANS)

Example 2 1984 Question 65

By definition, the peak value is $\sqrt{2}$ times the RMS. ∴ $V_{peak} = 0.7$ V

The period is $\frac{1}{50}$ = 0.02 sec

∴ D (ANS)

Example 3 1978 Question 68, 43%

No real transformer is ‘ideal’. Therefore all real transformers lose energy (as heat, noise).

∴ A (ANS)

Example 4 2006 Question 13, 75%

Transformer T_1 is a step up transformer.

∴The number of turns in the secondary needs to be greater than the number of turns in the primary.
To step the voltage up from 250 to 22 000, you need the number of turns in the secondary to be $\frac{22000}{250}$ times the number of turns in the primary.

$\frac{22000}{250} = 88.$

∴ $500 \times 88 = 44\ 000.$

∴ C (ANS)

Example 5 2011 QLD Question 13

Use: $\frac{V_1}{V_2} = \frac{N_1}{N_2}$

$\frac{200.0}{25.0} = \frac{400}{N}$

∴ N = 50

∴ B (ANS)

Example 6 2001 NSW Question 11

Use:

$\frac{V_1}{V_2} = \frac{N_1}{N_2}$

$\frac{110}{V_{out}} = \frac{60}{2300}$

$\therefore V_{out} = \frac{110 \times 2300}{60}$

$\therefore V_{out} = 4{,}217$ V

∴ D (ANS)

Example 7 2003 NSW Question 8

Use: $\frac{V_1}{V_2} = \frac{N_1}{N_2}$

$$\frac{240}{6000} = \frac{N_1}{N_2}$$

$$\therefore \frac{N_2}{N_1} = \frac{25}{1}$$

$\therefore$ **C (ANS)**

Example 8 2006 NSW Question 10

The secondary coil will show two spikes of twice the size (of the primary, due to twice as many turns), when the switch is turned on and off. The spikes will be different depending on whether the switch is being turned on or off. The voltage across the input will start at zero, increase to a constant and then decrease to zero.

$\therefore$ **A (ANS)**

Example 9 2010 NSW Question 10

The AC supply is the input. Therefore, Part 2 is the primary coil and Part 1 the secondary. The secondary coil has more turns, therefore, it is a step-up transformer.

$\therefore$ **D (ANS)**

Example 10 2012 NSW Question 10

A step-down transformer is required. Therefore, the secondary needs to have fewer turns than the primary. The ratio of turns is 10:1. Either side could be the input.

$\therefore$ **D (ANS)**

Example 11 2016 NSW Question 1

The phone requires a much smaller voltage than 230V. The process of converting AC to DC is typically done using diodes (no longer on the course).

$\therefore$ **D (ANS)**

Example 12 2017 NSW Question 14

The voltage across the resistor, V_1, will be constant for 2 seconds and then drop to zero for 2 seconds. There will be a spike in voltage V_2 when the current in the resistor changes from a constant value to zero at t = 2 sec.

∴ **A (ANS)**

Example 13 2002 NSW Question 6

Reducing the current in the wires will reduce the heating in the wires. To deliver a fixed amount of power, if you increase the voltage, the current will decrease.

∴ **A (ANS)**

Example 14 1984 Question 54, 47%

The power supplied is given by P = VI.
The resistance of power lines is assumed to be constant (or close to constant).
To deliver the Power, if the Voltage is stepped up, then the current will be reduced by the same factor.
In the equation $P_{loss} = V^2/R$, the value of V is the potential drop across the lines. IT IS NOT the potential.
If you transmit low voltage and high current, the potential drop across the lines will be given by V = iR, with a high current this means V_{drop} will be large.
To minimise loss, the transmission is done at high voltage but with a low current.

∴ **B, D (ANS)**

Example 15 2010 NSW Question 9

To reduce power loss in the cables, the voltage is stepped up. This means that to deliver a set amount of power, then the current is decreased. This minimises the effects of the resistance of the cables

∴ **C (ANS)**

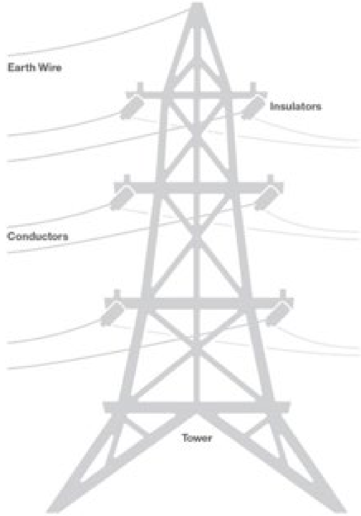
Example 16 2013 NSW Question 10

The transformer needs to be a step-up at the power station, then it will be stepped down in stages to eventually power the laptop

∴ **C (ANS)**

Example 17 2014 NSW Question 5

The high voltage lines have a single strand (called the Guardian wire, or Earth Wire) above the complex of conductors on the pylons. This is designed to attract the lightning (by being higher than the other wires), and send it to the ground, without impacting on the power carrying cables.



∴ **B (ANS)**

Example 18 1982 Question 71, 65%

The resistance of a wire is given by $R = \rho \frac{L}{A}$, where ρ (resistivity) is a property of the material.

Therefore, doubling the length would double the resistance, but the resistivity, ρ, would remain the same

∴ **B (ANS)**

Question 19 2007 Question 10, 65%

The alternator gradually speeds up from stationary implies that the frequency increases, i.e. the period decreases. As the frequency increases the output voltage will also increase.

∴ **C (ANS)**

Extended questions

Example 20 1985 Question 49

Use $P = \frac{V^2}{R}$,

$\therefore R = \frac{V^2}{P}$

$\therefore R = \frac{6^2}{24}$

$\therefore$ **1.5 Ω (ANS)**

Example 21 1985 Question 50

Use $V_{PEAK} = V_{RMS} \times \sqrt{2}$

$= 6 \times \sqrt{2}$

$\therefore$ **8.5 V (ANS)**

Example 22 1990 Question 57

$V_{RMS} = V_{PEAK} \div \sqrt{2}$

$\therefore V_{PEAK} = 5 \div \sqrt{2}$

$\therefore$ **V_{PEAK} = 3.5(4) V (ANS)**

Example 23 1990 Question 59

Use V = iR
Use either peak values OR RMS values.

$\therefore 5 = 3 \times R$

$\therefore$ **R = 1.67 Ω (ANS)**

Example 24 1985 Question 52, 51%

Use $R = \rho\frac{L}{A}$,

If the length is doubled the resistance will double. If the diameter is doubled the area will increase by a factor of 4, so the resistance will decrease by a factor of 4. Overall the resistance will decrease by a factor of 2

$\therefore$ **50 Ω (ANS)**

Example 25 2018 NSW Question 30

An increase in the number of appliances being used will increase the energy demand. This will be an increase in the current required, because the rate of energy use (Power) is given by P = VI. V is fixed at 240 V by the secondary of T2.
This increase in current will lead to an increase in the current in the transmission lines, which will decrease the voltage in the primary of T2, due to transmission losses. This means that more current must be supplied to T1.

The power station will need to supply more energy to meet the demand. The generators can't spin more quickly as that would change the frequency of the AC, so the field may need to be increased.

Example 26 2018 WA Question 1a

Use:

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

$$\frac{415}{11000} = \frac{N_P}{N_S}$$

$$\therefore \frac{N_P}{N_S} = \frac{1}{26.5}$$

$\therefore$ **Ratio = 1:26.5 (ANS)**

Example 27 2018 WA Question 1b

Use $P_{in} = P_{out}$

$\therefore (VI)_{in} = (VI)_{out}$

$\therefore 300 \times 10^3 = 11000 \times I_S$

$$\therefore I_S = \frac{300 \times 10^3}{11000}$$

$\therefore$ **I_S = 27.3 A (ANS)**

Example 28 1984 Question 70,

If the transformer is ideal, i.e. 100% efficient, then $P_{in} = P_{out}$

$\therefore (VI)_{in} = (VI)_{out}$

The Voltage is directly proportional to the number of turns

$\therefore N_1 \times I_1 = N_2 \times I_2$

$\therefore$ **$I_2 = I_1 N_1 / N_2$ (ANS)**

Example 29 2008 Question 14, 85%

Use:

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

$$\frac{240}{18} = \frac{N_1}{30}$$

$$N_1 = 30 \times \frac{240}{18}$$

$\therefore$ **N_1 = 400 (ANS)**

Example 30 2008 Question 15, 73%

Since the power input is the same as the power output. The input power must also be 40 W. The primary voltage is 240 V.

Using: P = VI

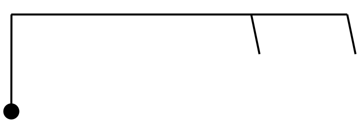
$$\therefore I = \frac{P}{V}$$

$$\therefore I = \frac{40}{240}$$

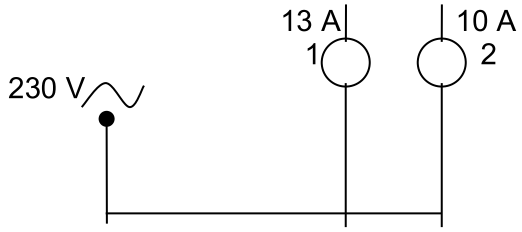
$\therefore$ **I = 0.17 A (ANS)**

Example 31 1997 Question 4, 40%

From reading the stem of the question very carefully, we glean that the currents in the two motors are different, so they must be connected in parallel, not in series.



Both will have 220 V across the motor.



You need to show that the generator supplied 230 V, and that motor 1 used 13 A, with 220 V across it, and motor 2 used 10 A with 220 V across it.
You will also need to consider that the charge loses 10 V of PD along the lines.

Example 32 1997 Question 5, 32%

The total power = VI, where V is the voltage that the power is supplied at (230 V), and I is the total current supplied, (23 amp)

P = 230 × 23
= 5290 W
= 5.29 × 10^3 W (ANS)

Example 33 1997 Question 6, 58%

The total power supplied is 5290 W.
Motor 1 uses P = VI
= 220 × 13
= 2860 W
Motor 2 uses P = VI
= 220 × 10
= 2200 W
So total power used by both motors is
2860 + 2200 = 5060 W
∴ 5290 - 5060 = 230W, must be the power being lost in the lines.
The other option was to consider that there was a voltage drop of 10 V across the lines, so if the lines were carrying a current of 23 Amp, then the power loss in the lines.
= V × I
= 10 × 23
= 230 Watt (ANS)

Question 34 2012 Question 4a, 88%

Power = VI
= 900 × 50
= 45 kW (ANS)

Question 35 2012 Question 4b, 55%

Use V = iR
Where V = 1000 V, and R is a total of 25 A
∴ 1000 = i × 25
∴ i = 40 A (ANS)

Question 36 2012 Question 4c, 50%

There will be a voltage drop along the wires. This is given by V = iR
∴ V = 40 × 7
∴ V_{drop} = 280 V

∴ $V_{supplied\ to\ motor}$ = 1000 – 280
= 720 V

The motor will not run properly, as it requires 900 V. ∴ the pump will not operate correctly.

Question 37 2012 Question 4d, 50%

First change
Use step-up transformer to increase the voltage that the power is delivered along the lines, and then use a step-down transformer at the other end.
Since the power delivered is given by
P = VI, if V is increased then I will decrease to deliver the same power.

The energy losses in the wire are given by
I^2R, so this will lower the energy losses due to heating in the wire.

Second change
Change the material that the wire is made from to one of lower resistance. This will lower the voltage drop across the transmission lines, which will lead to more power being available for the motor.

Example 38 2011 Question 13, 85%

Use Power = VI
= 50,000 × 15
= 750,000 W (ANS)
(We are finding the power, so we need to use the **RMS values** for the voltage and current.)

Example 39 2011 Question 14, 57%

Using P = VI, if the same power is to be delivered, then the lower voltage means a higher current.
Power loss in the wires is $P = I^2R$
Therefore a greater current increases the power loss.

Example 40 2011 Question 15, 85%

Use power loss = I^2R

$\therefore R = \frac{9000}{15^2}$

= 40 Ω (ANS)

(don't forget to square I)

Example 41 2011 Question 16, 75%

Since the transformer is *ideal* (as are all transformers on VCE exams), we can use
$VI_{in} = VI_{out}$

$\therefore 49\,400 \times I_{primary} = 250 \times I_{secondary}$

$\therefore \frac{49400}{250} = \frac{I_{secondary}}{I_{primary}}$

$\therefore \frac{I_{secondary}}{I_{primary}}$ **= 198 (ANS)**

(**Don't** leave your answer as a fraction).

Question 42 2009 Question 9, 90%

Use power = VI

$\therefore P = 500 \times 20$

$\therefore P = 10\,000$

= 1.0 × 10^4 W (ANS)

Question 43 2009 Question 10, 75%

The power loss in the lines is $P_{loss} = i^2R$

$\therefore P_{loss} = 20^2 \times 10$

(Use the total resistance of the wires)

$\therefore P_{loss} = 4000$

∴ P_{loss} = 4000 W (ANS)

Question 44 2009 Question 11, 63%

The output voltage of the generator is 500 V.
The potential drop across each line is given by V = iR

$\therefore V = 20 \times 5$

∴ V = 100V across each line.

The total of the potential drops of the circuit is 200V
Therefore the voltage supplied to the lights is 500 – 200

= 300 V (ANS)

Question 45 2009 Question 12, 75%

The step –up transformer will increase the voltage from 500V to

∴ 5000 V (ANS)

Question 46 2009 Question 13, 80%

The step-down transformer has a ratio of 10:1
Therefore the number of turns has to have this ratio

$\therefore$ 4800 ÷ 10 = 480

$\therefore$ **480 turns (ANS)**

Question 47 2009 Question 14, 55%

The step-up transformer increases the voltage by a factor of 10. To deliver the same power (P = VI) the current decreases by a factor of 10.
Therefore the new current is 20 ÷ 10 = 2 A
The power loss in the lines is given by
$P_{loss} = i^2R$

$\therefore P_{loss} = 2^2 \times 10$

(Use the total resistance of the wires)

$\therefore P_{loss} = 40$

$\therefore$ **P_{loss} = 40 W (ANS)**

Question 48 2009 Question 15, 47%

With the step-up transformer in place the current in the cables is 2.0 A.
The output voltage of the step-up transformer is 5000 V.
The potential drop across each line is given by V = iR

$\therefore V = 2 \times 5$

$\therefore$ V = 10V across each line.

The total of the potential drops of the circuit is 20V
Therefore the voltage supplied to the step-down transformer is 5000 – 20
= 4980 V
The transformer steps this voltage down by a factor of 10, so the output voltage of the step-down transformer is 4980 ÷ 10

= 498 V (ANS)

Example 49 2006 Question 9, 60%

The power being used is 10×10^5 W. This power is supplied at a voltage of 250 V.
Using P = VI
Gives $10 \times 10^5 = 250 \times I$

$$\therefore I = \frac{1\times10^5}{250}$$

= 400 A (ANS)

Example 50 2006 Question 10, 60%

Assume that the transformer is ideal,

$\therefore Power_{IN} = Power_{OUT}$

$\therefore (VI)_{IN} = (VI)_{OUT}$

$\therefore 22\,000 \times I = 10 \times 10^5$

$$\therefore I = \frac{1\times10^5}{22000}$$

$\therefore$ **I = 4.55 Amp (ANS)**
(rounded off to 2 decimal places)

Example 51 2006 Question 11, 60%

When 100kW of power is being used in the village the current in the high voltage lines is 4.55 Amp.
The power loss in the lines = i^2R
Where R = 2 Ω

$= 4.55^2 \times 2$

= 41 W (ANS)

Example 52 2006 Question 12, 60%

The power being delivered is given by P = VI. The power loss in the cables is given by $P = I^2R$.
To minimise power loss in the cables either 'I' or 'R' need to be kept to a minimum. The resistance of the cables is difficult to control or influence, so it is best to minimise 'I'.

As the power being delivered is given by P = VI, then to keep the power delivered constant, if 'I' decreases then 'V' needs to increase by the same factor.
An increase in V allows a decrease in I, which means that losses related to I^2R are lowered.

Example 53 1999 Question 1, 70%

Use $P = V \times I$

$60 = 240 \times I$

$\therefore I = 60 \div 240$

= 0.25 Amp (ANS)

Example 54 1999 Question 2, 78%

The ratio of the number of turns in the primary coil : secondary coil is the same as the input voltage : output voltage. Remember always think about the 'voltages'.

$$\therefore \quad \frac{264}{240} = \frac{1000}{'x'}$$

$$\therefore x = \frac{240 \times 1000}{264}$$

∴ x = 909 turns (ANS)

Example 55 1999 Question 3, 60%

The voltage across globe 'x' needs to be 24 V.
The current in both globes will be the same, because they are connected in series.
The current in the 240 V globe is found from

$P = V \times I$

$60 = 240 \times I$

$I = 0.25$ Amp

∴ the power in the 24 V globe

$P = V \times I$

$= 24 \times 0.25$

= 6 Watt (ANS)

Example 56 1999 Question 10, 60%

If the transformer is ideal then the power out = power in

∴ $500 \times 10^3 \times 300 = 20 \times 10^3 \times I$

∴ $\therefore I = (500 \times 10^3 \times 300)/20 \times 10^3$

∴ **∴ I = 7500 Amp (ANS)**

Example 57 1999 Question 11, 70%

Power loss in transmission lines is given by i^2R

$= 300^2 \times 8$

$= 720000$

$= 7.2 \times 10^5$ W (ANS)

Example 58 1999 Question 12, 45%

The voltage drop will be given by $P = \Delta V \times I$

$7.2 \times 10^5 = \Delta V \times 300$
$\Delta V = 7.2 \times 10^5 \div 300$
$\Delta V = 2400$ V
∴ the Voltage at the local area transformer
= 500 000 - 2400
= 4.98×10^5 V (ANS)
(Correct to 3 sig. figs.)

Example 59 1998 Question 2

If the Power loss is given by i^2R
∴ $P = 10^2 \times 3$
= 300 W
= 3.0×10^2 W (ANS)
(correct to 2 sig. figs)

Example 60 1998 Question 3

Power losses due to heating in transmission lines are given by $P = i^2R$.
To minimise this we need to minimise I. Since the power input is P = V × I, this means we need to increase V as much as possible.
We use a step-up transformer at 'T_1'. The step-up transformer steps up the voltage but steps down the current, resulting in a lower electric current in the cables and reduced power loss within the cables.
We then need to use a step-down transformer 'T_2' at the motor, to reduce the voltage to the original value, 400 V.

Example 61 1998 Question 4

If the initial current was 10 A, and the new current is 0.5 A, then the current has decreased by a factor of 20. This means that the potential difference between A and B must increase by a factor of 20. This is because in ideal transformers the power in = power out.
So $VI_{in} = VI_{out}$.
So the new voltage across AB will be
400 × 20 = 8,000 V
= 8.0×10^3V (ANS)

Example 62 1998 Question 5

The voltage across AB increases by a factor of 20. So it must be a step-up transformer. This means that the number of turns in the **primary** will be 5000 ÷ 20 = 250 turns.

Example 63 1997 Question 1, 80%

The ratio of the number of turns in the primary coil : secondary coil is the same as the input voltage : output voltage. Remember always think about the 'voltages'.

$$\therefore \quad \frac{240}{110} = \frac{1440}{'x'}$$

$$\therefore x = \frac{1440 \times 110}{240}$$

∴ x = 660 turns (ANS)
(Check that your answer makes sense by asking the following questions. Is it a 'step-down' or 'step-up' transformer? In this case it is a step-down transformer because the output voltage is less than the input voltage. This then means that the number of turns in the secondary coil must be less than the primary coil.)

Example 64 1997 Question 2, 40%

We are told that the transformer is 'ideal'. This means that the power in = power out.
So $(V \times I)_{in} = (V \times I)_{out}$. The power out is the rating of the globe. It is rated as 220W, so the power in must equal 220W.

So P_{in} = 220 = V × I
= 240 × I
∴ I = 220 ÷ 240
= 0.92 Amp (ANS)

Example 65 1997 Question 3, 25%

In Method 1, some power is used in the resistor, this is given by $V^2 \div R$.
V = 240 - 110
= 130 Volt (sum of voltages drops around the circuit = 240 V)
So power used in resistor
= $130^2 \div 65$
= 260 W.
∴ total power used in circuit
= 260 + 220
= 480 W
In method 2, the power loss is 220 W. Because the globe is the only appliance that is using power.

Example 66 1987 Question 66, 84%

This is a step down transformer so the number of secondary turns are less than the number of turns in the primary.

Use $\frac{240}{24} = \frac{1000}{N}$

$\therefore N = \frac{1000 \times 24}{240}$

∴ **N = 100 turns (ANS)**

Example 67 1987 Question 67, 67%

The peak current will be the RMS × $\sqrt{2}$
∴ 10 × $\sqrt{2}$
∴ **I_{peak} = 14 A (ANS)**

Example 68 1987 Question 68, 52%

The power supplied, $(VI)_{in}$ is the same as the power out $(VI)_{out}$ (from the question, as we assume that there are no losses in the transformer)
Use P = VI
∴ P_{out} = 24 × 10
∴ **P_{in} = 2.4×10^2 W (ANS)**

Example 69 1987 Question 69, 41%

Transformers require a changing flux (voltage) to operate. This can be either AC (most often) or a time varying DC voltage.
Since this is connected to a (constant) DC supply of 240 V, there will not be any current in the secondary coil
∴ **zero (ANS)**

Question 70 1988 Question 56

Use $V_{peak} = V_{RMS} \times \sqrt{2}$

$\therefore V_{peak} = 1000 \times \sqrt{2}$

$\therefore V_{peak} = 1414$

$\therefore$ **V_{peak} = 1400 V (ANS)**

Question 71 1988 Question 57

Use: $\frac{V_1}{V_2} = \frac{N_1}{N_2}$

$\frac{1000}{250} = \frac{2000}{N_2}$

$\therefore$ **N_2 = 500 turns (ANS)**

Question 72 1988 Question 58

The power supplied by the alternator = 200×10^3 W.

Use P = VI, where I is the current in the transmission lines

$\therefore 200 \times 10^3 = 1000 \times I$

$\therefore$ **I =- 200 A (ANS)**

Question 73 1988 Question 59

The power loss in the transmission cables is given by $P = i^2R$,

$\therefore P = 200^2 \times 0.20$

$\therefore P = 8000$

$\therefore$ **P = 8.0 × 10^3 kW (ANS)**

Question 74 1988 Question 60

To deliver a fixed amount of power, a step up transformer is used at the alternator. This transformer increases the voltage, and decreases the current whilst delivering the same power. Since the power, $VI_{in} = VI_{out}$ in an ideal transformer.

The power losses in transmission lines is given by I^2R.

So a decrease in I, results in an I^2 reduction in the energy losses in the wires.

A step-down transformer is used at the other end of the transmission lines to bring the voltage down to a suitable level for the mill

Example 75 1993 Question 6

Using Kirchhoff's law, the current in must equal the current out.

The current out is 5A in the Neutral + 2A in the earth = 7A.

Therefore the current in must be:

$\therefore$ **7 A (ANS)**