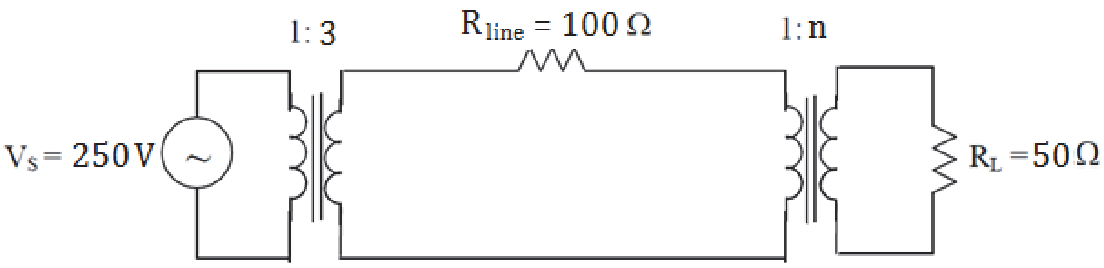
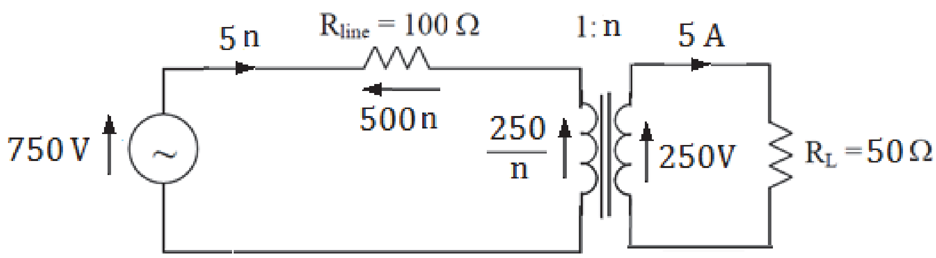
Q.3 Shown in the figure below is an electric power supply system transmitting electric power generated by a power station to a device with an equivalent resistance of 50 Ω. The device can only be properly operated with an AC voltage of 250 V (rms). It can be shown that $n = 0.5$ is one of the turn ratio values for the second transformer, which will meet the requirements.



(a) Find another turn ratio value for n that will meet the requirements as well.

(5 Marks)

Solution: Redraw the circuit as below with all necessary voltages and current labeled:



By KVL,

$$500n + \frac{250}{n} = 750 \quad \Rightarrow \quad 2n^2 - 3n + 1 = 0 \quad \Rightarrow \quad n = 0.5 \quad \& \quad n = 1$$

(b) Determine the total power consumed by the two transformers.

(5 Marks)

Solution: Ideal transformers do not consume power.

Thus, the total power consumed by the transformers is zero (0).

(c) For $n = 0.5$, determine the power supplied by the source.

(5 Marks)

Solution: For n = 0.5, the power consumed by the transmission line

$$P_{\text{line}} = 5n \times 500n = 2500n^2 = 2500 \times 0.5^2 = 625 \text{ W}$$

The power consumed by the load

$$P_{\text{load}} = 5^2 \times 50 = 1250 \text{ W}$$

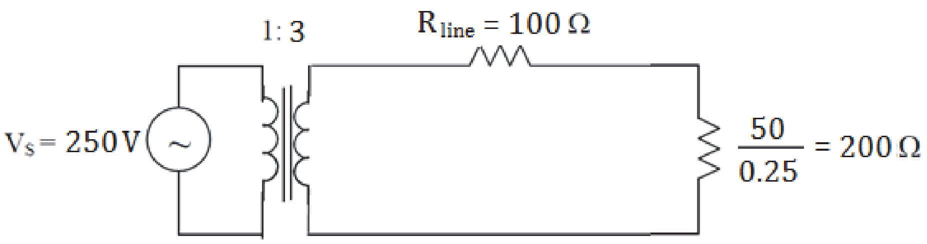
The total power supplied by the source is given by

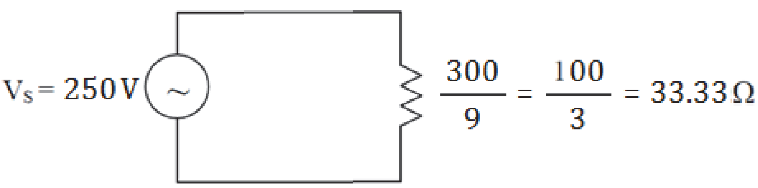
$$P_{\text{source}} = P_{\text{line}} + P_{\text{load}} = 625 + 1250 = 1875 \text{ W}$$

(d) For $n = 0.5$, determine the total equivalent resistance seen by the voltage source.

(5 Marks)

Solution:





(e) What else is needed if the load device can only take a constant voltage?

(5 Marks)

Solution: A rectifier circuit (either a half wave or full wave or full wave bridge) with a capacitor whose capacitance is sufficiently large is required.

Q.4 EG1108 is a module with a fairly large class size. The module lecturer wants to design a digital device that would signal him to start lecturing under certain conditions. The device will contain a noise measurement sensor (**N**) measuring the noise level in the lecture theatre (LT), a counter (**C**) counting the number of students showing up in the LT, and a timer (**T**) counting the time that the lecture is being delayed. These sensors will operate as follows:

- **N** will be high if the noise level is greater 99 dB. Otherwise, it remains low.
- **C** will be high if the number of students showing up is more than two-third of the official class size. Otherwise, it is low.
- **T** will be high if the delay is more than 5 minutes. Otherwise, it is low.

Design the device to trigger an alarm (**A**) for the lecturer to start lecturing under either one of the following conditions:

- **T** is high
- **N** is low and **C** is high

(a) Follow the format set in the lecture notes to construct a truth table with inputs **N**, **C** and **T**, and output **A**. No credit to be awarded if the truth table does not follow the standard format.

(10 Marks)

<u>Solution:</u> The truth table

	N	C	T	A
0	0	0	0	0
1	0	0	1	1
2	0	1	0	1
3	0	1	1	1
4	1	0	0	0
5	1	0	1	1
6	1	1	0	0
7	1	1	1	1

(b) Obtain the logical expression for **A** in the SOP form with all the necessary minterms.

(5 Marks)

Solution: The truth table

$$A = \overline{N}\cdot\overline{C}\cdot T + \overline{N}\cdot C\cdot\overline{T} + \overline{N}\cdot C\cdot T + N\cdot\overline{C}\cdot T + N\cdot C\cdot T$$

(c) Simplify the logical expression obtained in Part (b) using the K map technique.

(5 Marks)

Solution: The K map

	$N\cdot C$	$N\cdot\overline{C}$	$\overline{N}\cdot\overline{C}$	$\overline{N}\cdot C$
T	1	1	1	1
$\overline{T}$	0	0	0	1

$$A = T + \overline{N}\cdot C$$

(d) Draw a logic circuit realization for the logical expression obtained in Part (c) using no more than 3 logic gates (any type of logic gates is acceptable).

(5 Marks)

Solution: Logic circuit realization