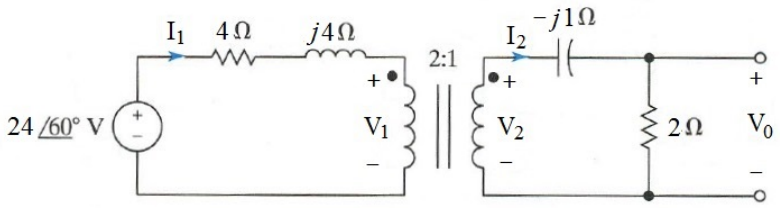
Q.3 Shown in the figure below is a transformer circuit.



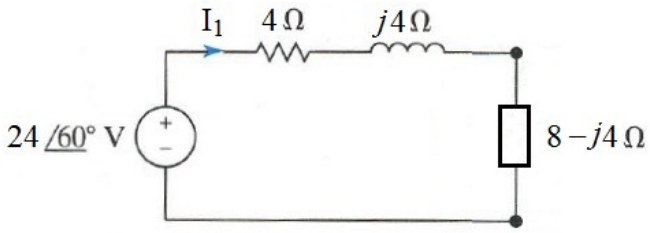
(a) Find V_0 in the phasor form.

(10 Marks)

Solution: Using the equivalent load of the transformer circuit, we can convert the given circuit into the following form with an equivalent load

$$Z_{\text{equivload}} = \frac{2-j}{\left(\frac{1}{2}\right)^2} = 8 - j4$$

or



$$\mathrm{I}_1 = \frac{24\angle 60^\circ}{4 + j4 + 8 - j4} = \frac{24\angle 60^\circ}{12} = 2\angle 60^\circ$$

$$\mathrm{I}_2 = \frac{\mathrm{I}_1}{n} = \frac{2\angle 60^\circ}{1/2} = 4\angle 60^\circ$$

$$\mathrm{V}_0 = 2\,\mathrm{I}_2 = 8\angle 60^\circ \text{ V}$$

(b) Given the frequency of the AC source f = 50 Hz, find the corresponding time domain function of the output, $v_0(t)$.

(5 Marks)

Solution: Ideal transformers do not consume power.

$$v_0(t) = 8\sqrt{2}\cos(\omega t + 60°) = 8\sqrt{2}\cos(2\pi f t + 60°) = 11.3137\cos(314\,t + 60°)\ \text{V}$$

(c) Can the output voltage $v_0(t)$ be connected to a rectified circuit to produce a constant DC output voltage of 30 V? If the answer is no, suggest a solution to the problem.

(10 Marks)

Solution: The maximum constant DC voltage that a rectified circuit can produce is the peak value of the AC input, which is 11.3137 V.

Thus, the output voltage $v_0(t)$ cannot be connected to a rectified circuit to produce a constant DC output voltage of 30 V.

Another transformer is needed to step up 11.3137 V to 30 V in order to produce a 30 V DC output.

Q.4 A long hallway has three doors, one at each end and one in the middle. Each door side has a switch to control the hallway's light. The light is off when switch variables, $\mathbf{S_1}$, $\mathbf{S_2}$ and $\mathbf{S_3}$, have the values 0, 0 and 0. Otherwise, the light is on. Design a combinational network that controls the light (**L**).

(a) Follow the format set in the lecture notes to construct a truth table with inputs $\mathbf{S_1}$, $\mathbf{S_2}$ and $\mathbf{S_3}$, and output **L**. No credit to be awarded if the truth table does not follow the standard format.

(10 Marks)

Solution: The truth table

	S_1	S_2	S_3	L
0	0	0	0	0
1	0	0	1	1
2	0	1	0	1
3	0	1	1	1
4	1	0	0	1
5	1	0	1	1
6	1	1	0	1
7	1	1	1	1

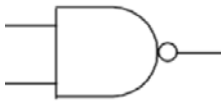
(b) Obtain the logical expression for **L** in the POS form with all the maxterms.

(5 Marks)

Solution: The truth table

$$L = S_1 + S_2 + S_3$$

(c) Draw a logic circuit realization for the logical expression obtained in Part (b) using no more than 6 two-input only NAND gates (i.e., each NAND gate has only two inputs):



(10 Marks)

Solution:

$$L = \overline{\overline{S_1 + S_2 + S_3}} = \overline{\overline{S}_1 \cdot \overline{S}_2 \cdot \overline{S}_3} = \overline{\overline{\overline{S}_1 \cdot \overline{S}_2 \cdot \overline{S}_3}}$$

Logic circuit realization