Mid Sem - 2024

EE-238, Solution.

Q1. In continuous mode of conduction.

$$V_o = \frac{\delta}{1-\delta} V_d \quad \text{or} \quad \frac{150}{100} = \frac{\delta}{1-\delta} \quad \text{or} \quad \delta = 0.6$$

The o/p current below which the converter enters into discontinuous mode of conduction at $\delta = 0.6$ is

$$I_{OB} = \frac{V_d T}{2L} \delta(1-\delta) \qquad V_d = 100, \quad T = \frac{1}{5\times10^3} = 0.2\times10^{-3} s$$

$$= \frac{100 \times 0.2 \times \cancel{10^{-3}}}{2 \times 2.5 \times \cancel{10^{-3}}} \times 0.6 \times 0.4 \text{ A} = 0.96 \text{ A}.$$

The o/p current of the converter is $\frac{150}{500}$ A $= 0.3$ A.

As $0.3\text{ A} < 0.96\text{ A}$ $\Rightarrow$ the converter is operating in disc. mode and $\delta \neq 0.6$. — 2 marks

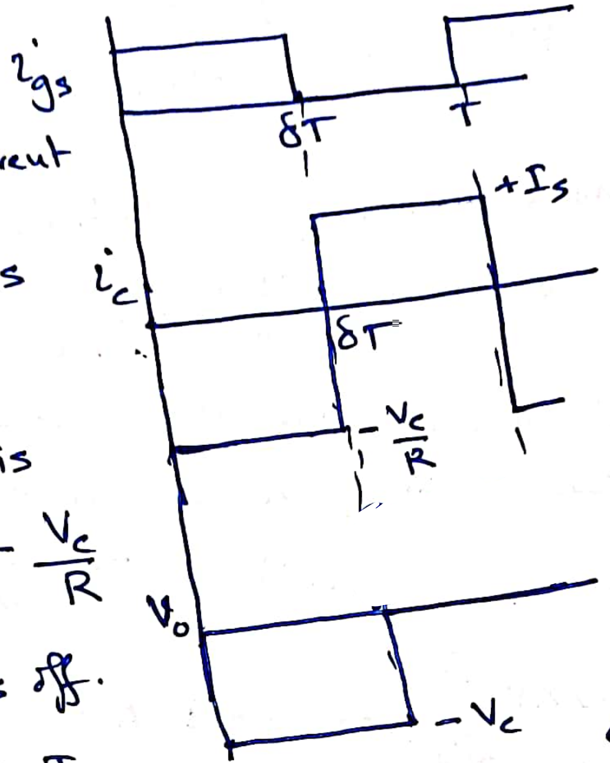
$$\therefore \quad \frac{V_o}{V_d} = \frac{V_d T}{2L} \times \frac{\delta^2}{I_o} = 4 \times \frac{\delta^2}{0.3} = \frac{150}{100}$$

$$\text{or} \quad \delta^2 = \frac{150 \times 0.3}{400} = 0.1125 \qquad \text{3 marks}$$

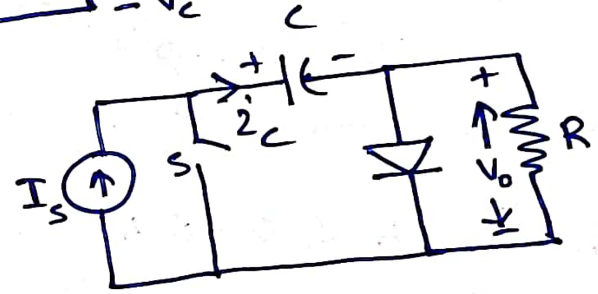
or $\delta = 0.335$ (discarding ~~neglecting~~ the -ve value.)

While testing continuous mode or discontinuous mode of operation if δ is considered to be 0.5, and I_{OB} is considered to be $\frac{V_d T}{8L} = \frac{100 \times 0.2 \times 10^{-3}}{8 \times 2.5 \times 10^{-3}} = 1$ A — deduct 1 mark.

Q2.



Let the current through the capacitor is i_c



2 marks When S is on, $i_c = -\frac{V_c}{R}$

When S is off.

2 marks $i_c = +I_s$

When S is on, $V_o = -V_c$

When S is off, $V_o = 0$

2 marks as the diode is is conducting.

Average current through C is zero at steady state

$$\therefore -\frac{V_c}{R}\delta T + I_s(1-\delta)T = 0$$ 2 marks

$$\text{or,} \quad V_c = \frac{RI_s(1-\delta)}{\delta}$$

ii)

$$V_o = -V_c\,\delta T/T = -V_c\delta = -RI_s(1-\delta)$$ 2 marks

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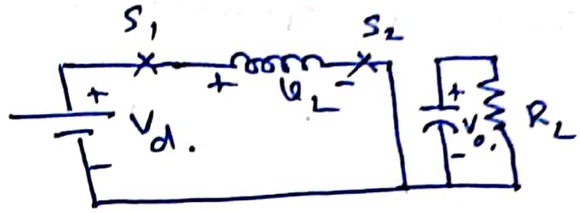
Q3. When S_1 and S_2 are on :

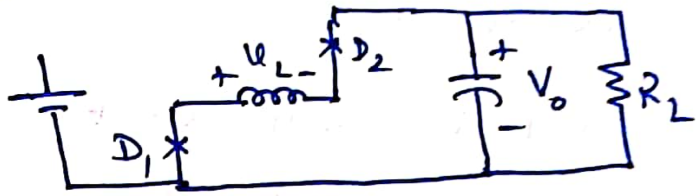
the equivalent ckt :

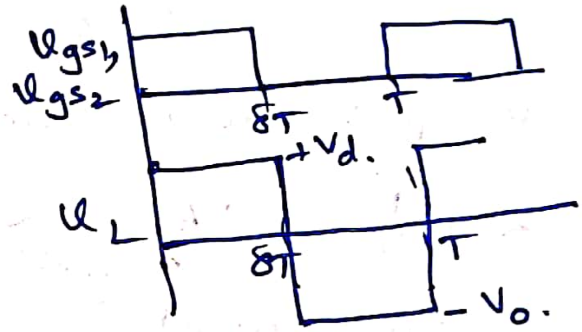


The voltage across the inducter, $v_L = + V_d$.

2 marks

When S_1 and S_2 are off, D_1 and D_2 conduct, and the voltage across the inductor, $v_L = - V_o$





Average voltage drop across any inductor is zero

$$\therefore \; V_d \delta T - V_o (1-\delta) T = 0$$

2 marks

or $$\frac{V_o}{V_d} = \frac{\delta}{1-\delta}$$

the circuit is functioning as a buck-boost converter —— 0.5 marks

in non-inverting mode —— 0.5 mark

Q4

Let us assume that the flyback converter is operating in continuous mode of operation

$$\therefore V_o = \frac{N_2}{N_1} \cdot \frac{\delta}{1-\delta} \, 100 = \frac{1}{2} \cdot \frac{0.25}{0.75} \times 100 = 16 \text{ V}$$

the o/p voltage is 80V, hence it is operating in disc. mode.

The peak switch current = peak magnetizing current

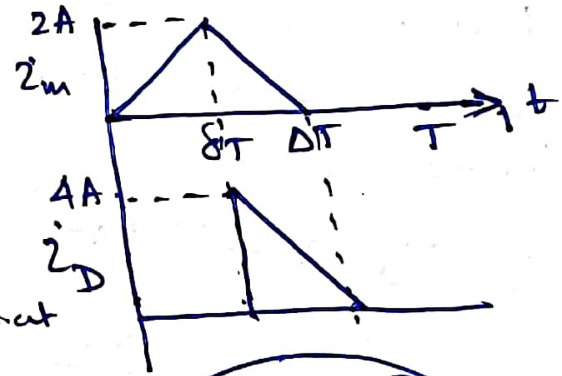
$$= I_{Lp} = \frac{100 \times 0.25 \times 20 \times 10^{-6}}{250 \times 10^{-6}} = 2\text{A}$$

2 marks

Now, the peak diode current

$$= 2 \times \frac{N_1}{N_1} = 4\text{A}$$

2 marks



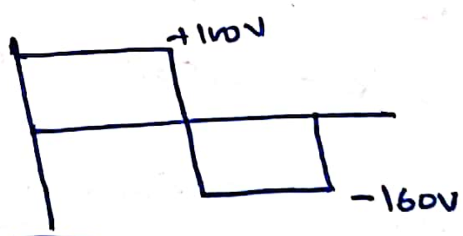
Average diode current

$$= \frac{1}{2} \, 4 \times \Delta T \times \frac{1}{T} = \text{Average Load current}$$

$$\text{or} \quad 2\Delta = \frac{80}{R_L} \quad \text{or} \quad \Delta = \frac{40}{R_L} \quad \text{---(1)}$$

3 marks

$\because$ Average voltage drop across the magnetizing inductance is zero



$$100\,\delta T - 160\,\Delta T = 0$$

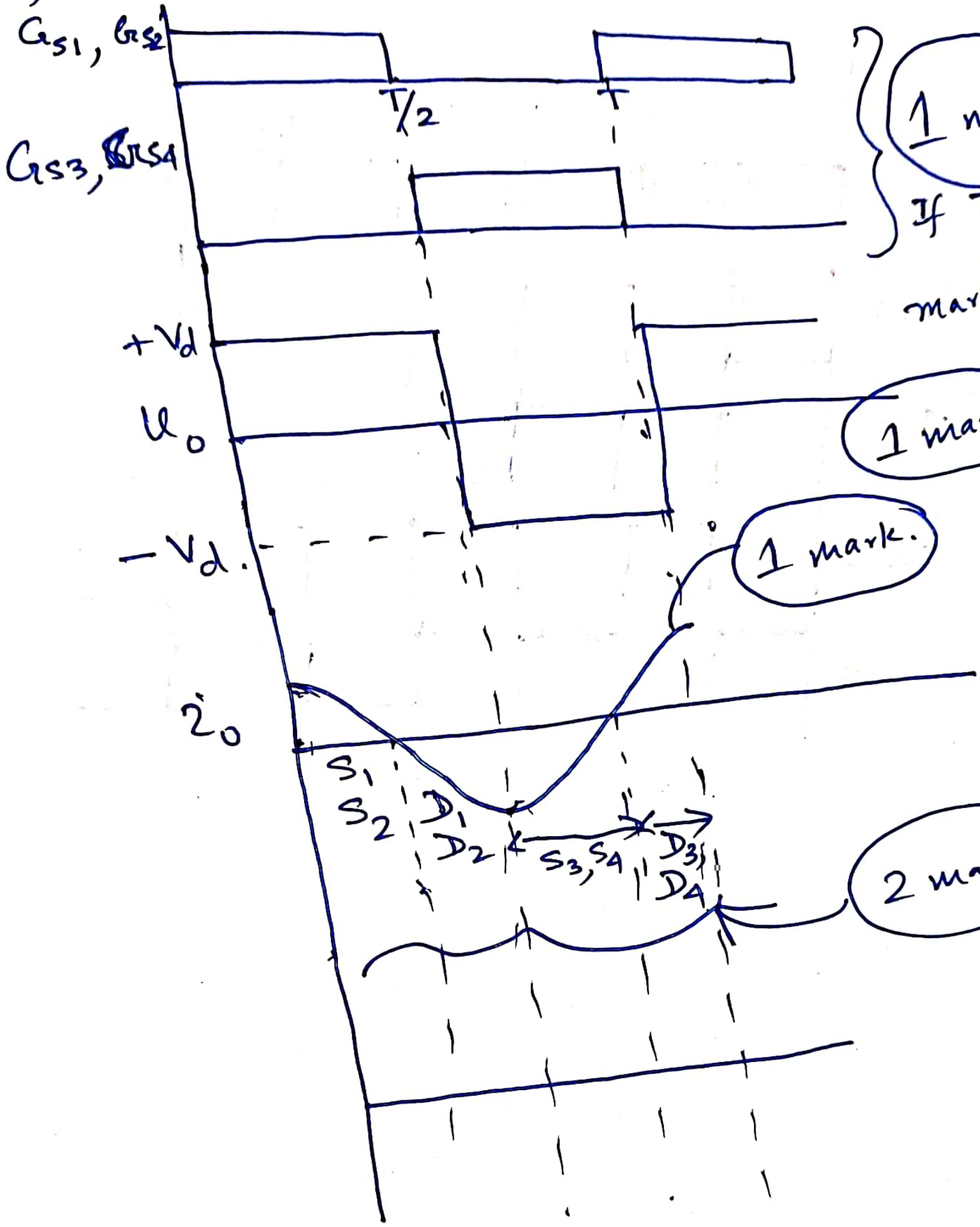
$$\text{or} \quad \Delta = \frac{100}{160} \times 0.25 = 0.156$$

3 marks

$$\text{By (1)} \quad \frac{40}{R_L} = 0.156$$

$$\therefore R_L = 256.41\,\Omega.$$

Q5 A)



1 mark

If $T/2$ and T are not marked deduct $1/2$ mark.

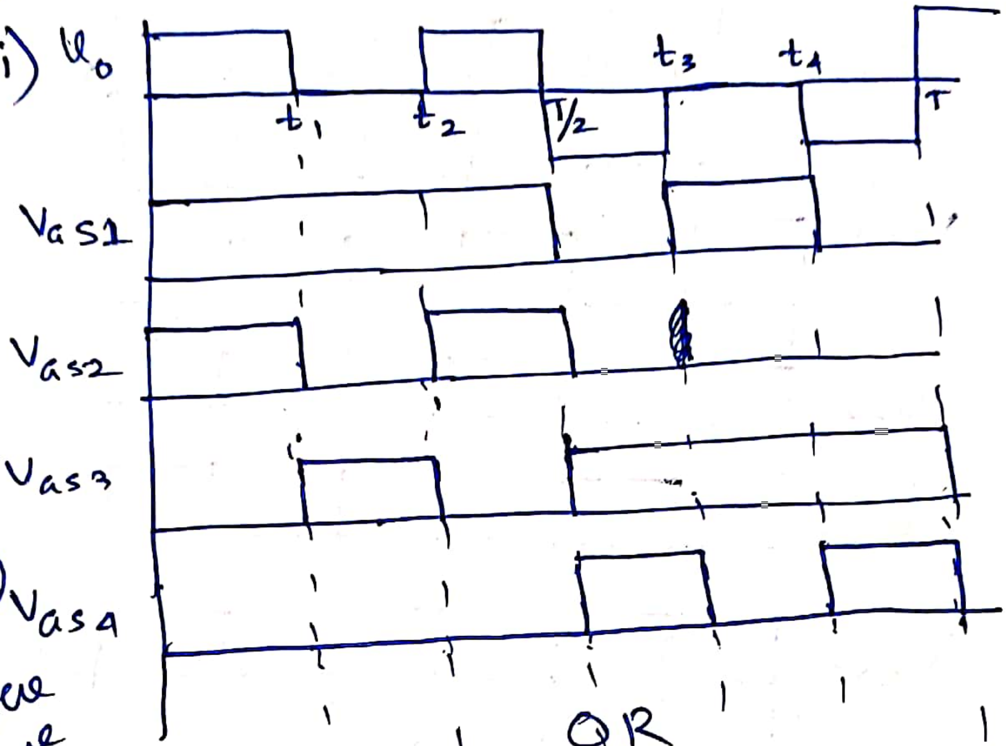
1 mark.

1 mark.

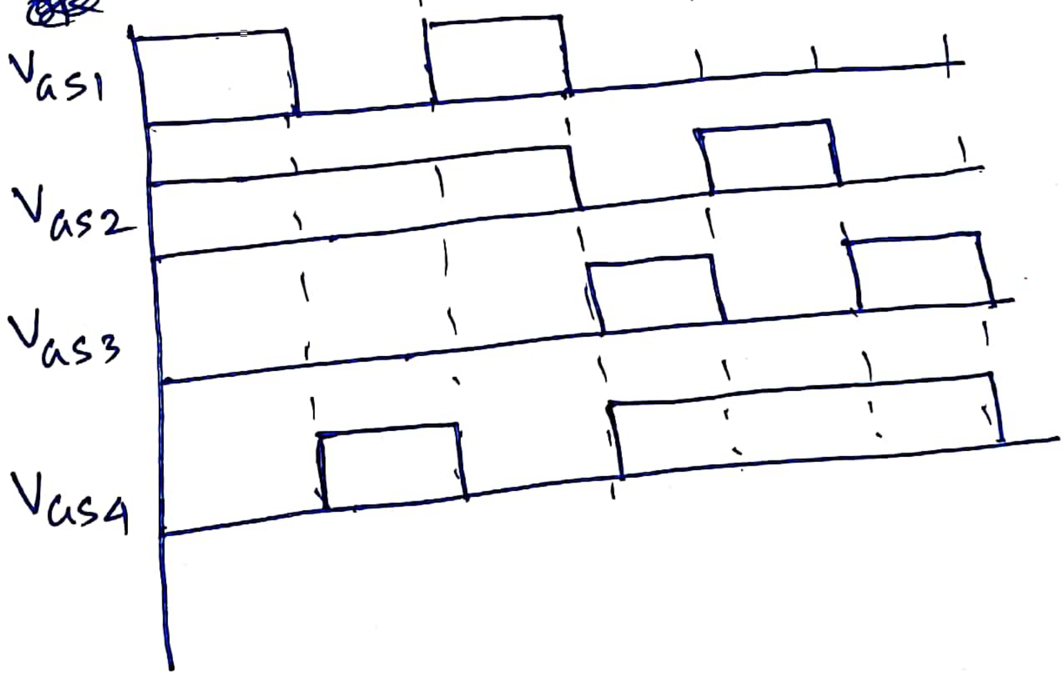
2 marks.

Q5 B)

i)



OR



3 marks if any one of the options are provided.

If all the switches are kept open during the 'zero' instant of v_o, no credit to be given.

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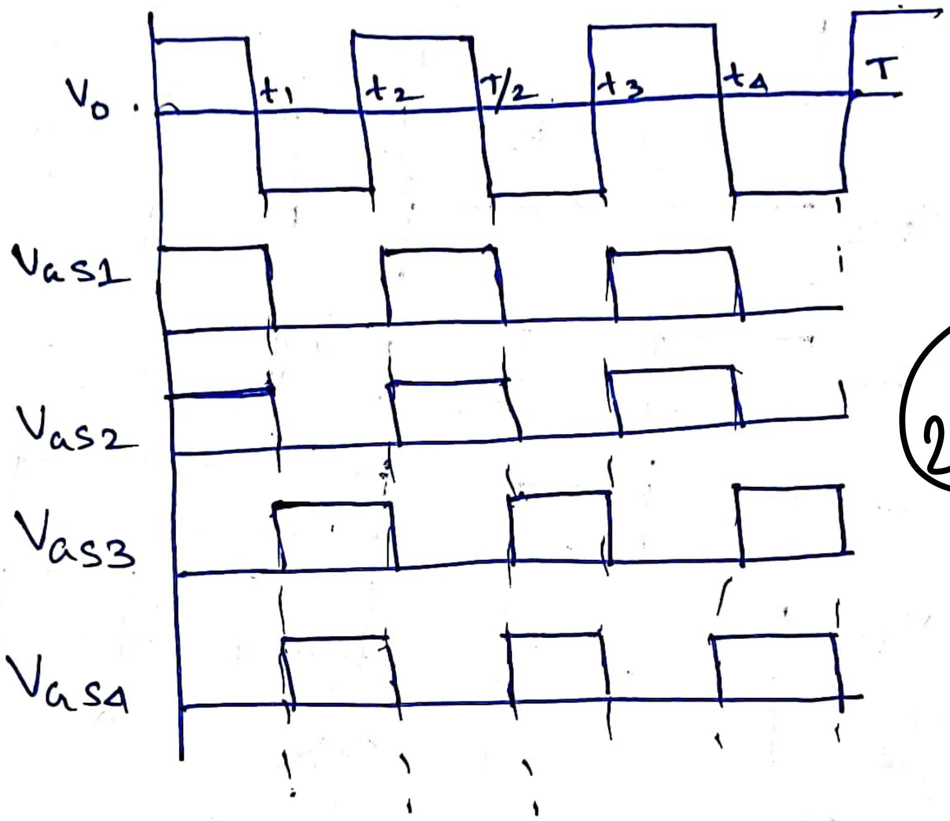
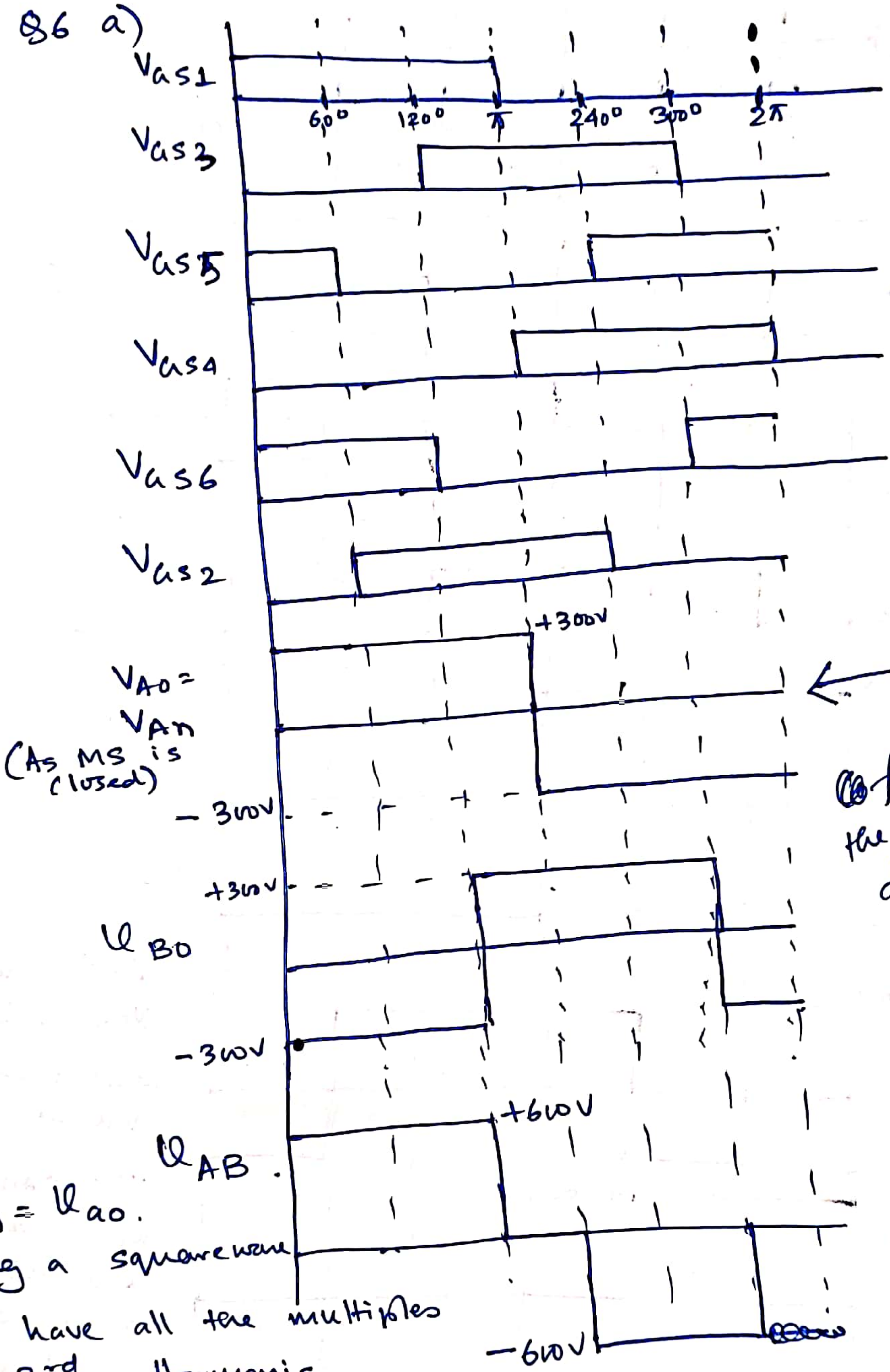
Q5 B

ii)



2 marks

Q6 a)



1 mark.

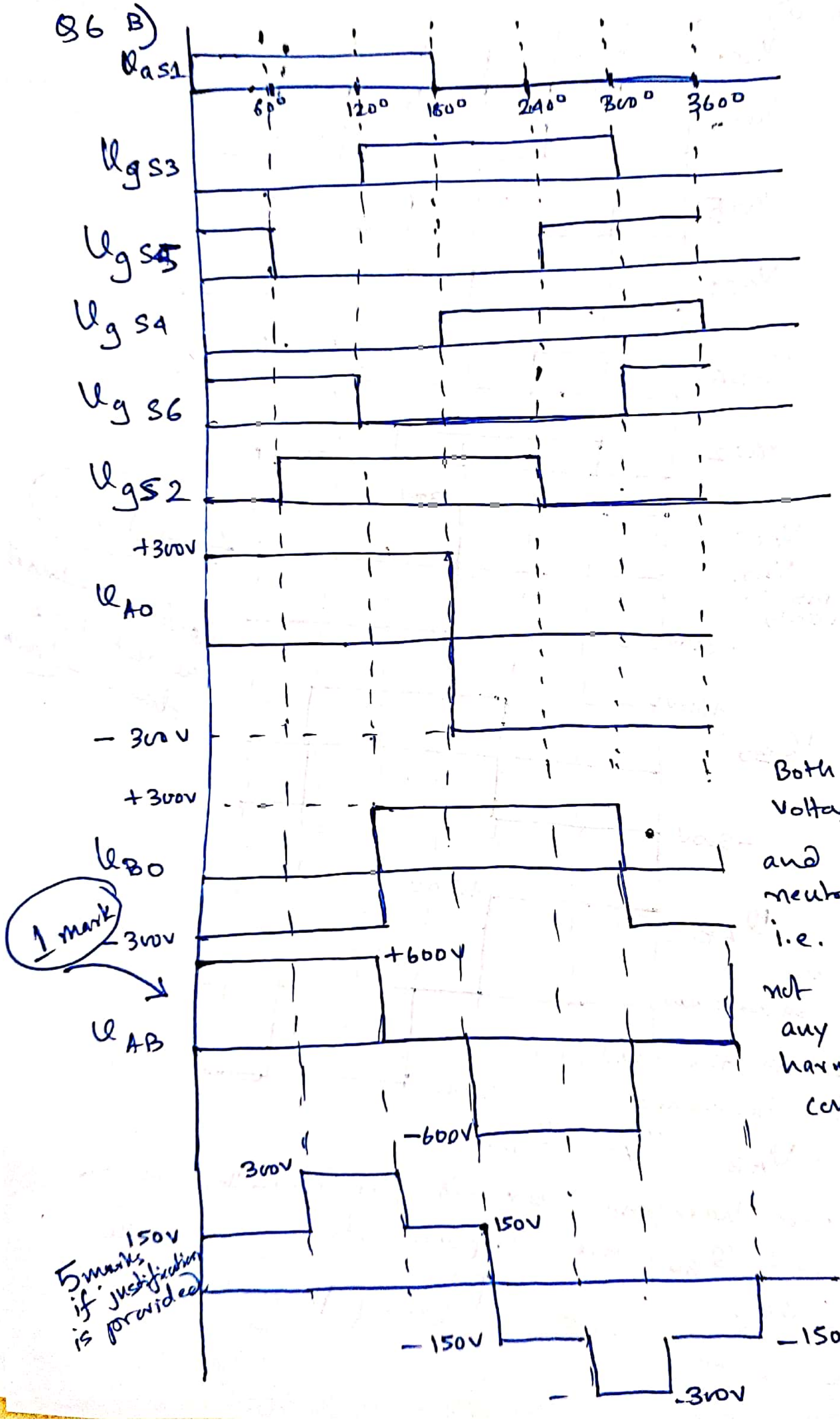
for correctness of the rest of the diagram — 1 mark

$v_{An} = v_{ao}$. being a squarewave will have all the multiples of 3rd Harmonic

While $V_{AB} = v_{Ao} - v_{Bo}$, ~~the~~ the third harmonics will get cancelled as the v_{Ao} and v_{Bo} are displaced from each other by 120°.

1 mark.

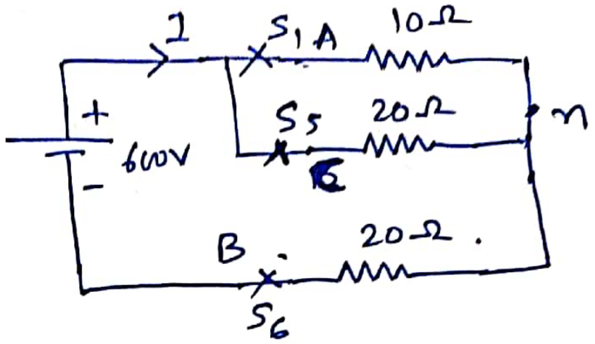
Q6 B)



Both line to line voltage, i.e. V_{AB} and Phase to neutral voltage i.e. v_{AN} do not have any third harmonic component.

1 mark

1) 0 to 60^0



$$I = \frac{600}{\frac{\cancel{200}}{3\cancel{0}} + 20} \text{ A}$$

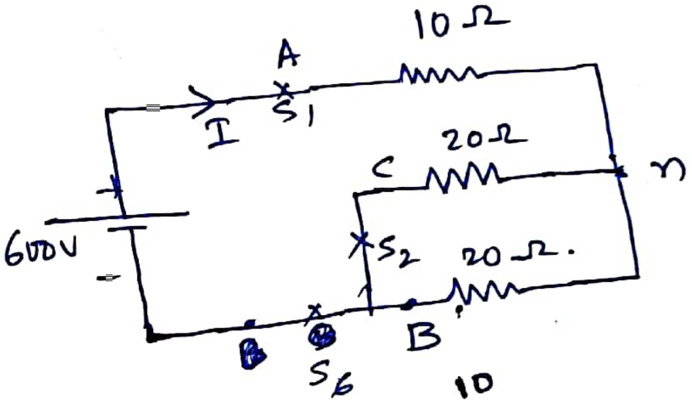
$$= \frac{600}{\frac{80}{3}} = \frac{\overset{15}{\cancel{600}} \times 3}{\underset{2}{\cancel{80}}}$$

$$= 15 \times \frac{3}{2} \text{ A.}$$

$\therefore$ Voltage drop $v_{nB} = 15 \times \frac{3}{\cancel{2}} \times \overset{10}{\cancel{20}} = 450.$

$\therefore$ Voltage drop $v_{An} = v_{cn} = 600 - 450 = \underline{150 \text{ V.}}$

2) 60° to 120^0

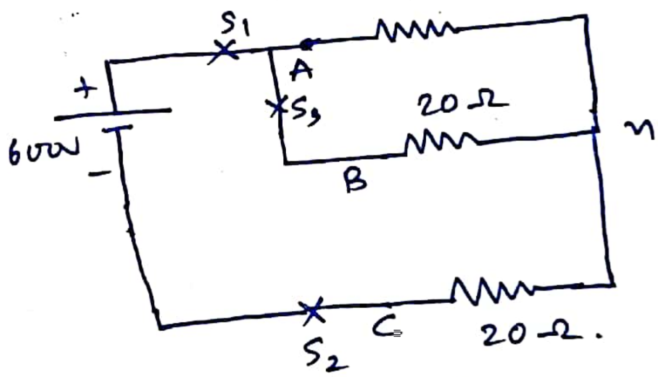


$$I = \frac{600}{20} \text{ A.}$$

$$\therefore V_{An} = \frac{600}{2\cancel{0}} \times 1\cancel{0}$$

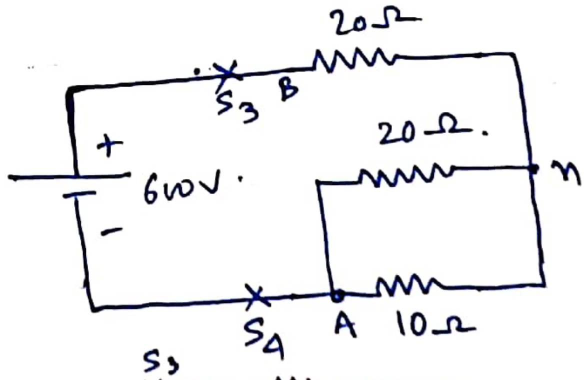
$$= \underline{300 \text{ V.}}$$

3) 120° to 180^0



$v_{An} = 150$ V.

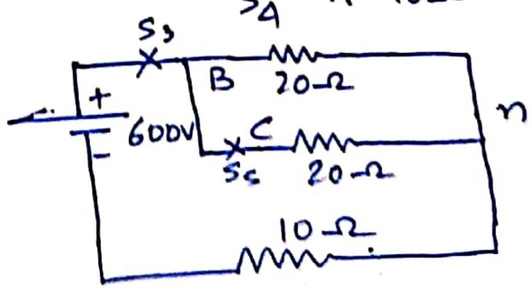
4) 180° to 240^0



$v_{nA} = +150$V

$\therefore v_{An} = -150.$

5) 240° to 300^0



$v_{nA} = 300$ V

$\therefore v_{an} = -300$ V.