ALVAS INSTITUTE OF ENGINEERING AND TECHNOLOGY, MIJAR, MOODBIDRI

Department of Electronics and Communication Engineering

POWER ELECTRONICS [10EC73] – 7th Sem 'A' &'B' Section

Faculty In-charge: Mrs. Jyothi Pramal & Ms. Prithvi P Shetty

USN: 4AL

Time: $1^1/_2$Hour **Max.marks:50**

II- Internal (27/10/16)

Note: *Answer any* ***Two Full*** *questions in each Part.*

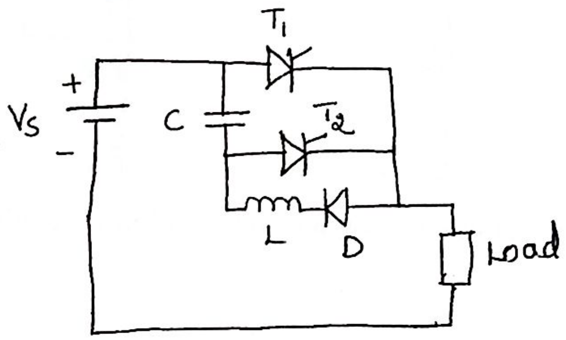
PART-A

1. a) Explain two transistor model of thyristor and derive an expression for anode current in terms of the current gain α_1 and α_2 of the transistors. **7.5M**

b) Distinguish between natural and forced commutation. **5M**

2. a) With a neat figure explain the dynamic turn-on and turn-off characteristics. **8M**

b) In an auxiliary commutation circuit, the battery voltage is 100V. Maximum load current is 40A and thyristor turn-off time is 40μsec. Assume 50% tolerance on turn off time. Find L and C of commutation circuit. **4.5M**



3. a) Briefly explain di/dt and dv/dt protection of SCR. **5.5M**

b) With the neat circuit diagram and waveforms, explain resonant pulse commutation. **7M**

PART- B

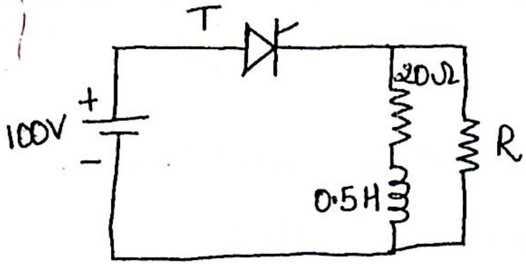
4. a) With the necessary circuit diagram and waveform, explain the operation of complementary commutation. **8M**

b) State the conditions to be satisfied for proper turn-off of SCR. **4.5M**

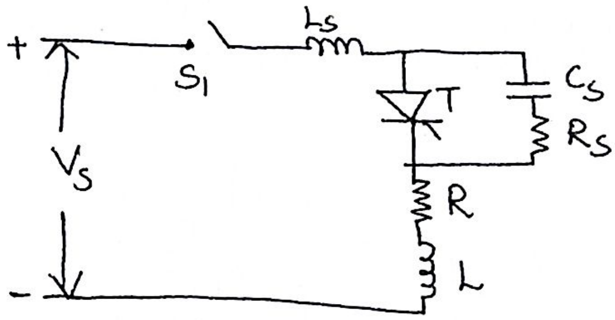
(P.T.O)

5. a) With the neat circuit diagram and waveform, explain the auxiliary voltage commutation. 8M

b) In the thyristor circuit shown in Fig below, the SCR has a latching current of 50mA and is fired by a pulse of length 50μsec. Show that without the resistor R, the thyristor will fail to remain on when the firing pulse ends and then find the maximum value of R to ensure firing. 4.5M



6. a) The input voltage Fig below is V_S=200V with load resistance of R=5Ω. The load and stray inductances are negligible and the thyristor is operated at a frequency of f_s=2kHz. If the required dv/dt is 100V/μS and the discharge current is limited to 100A. Determine i) the values of R_S and C_S ii) the snubber loss, and iii) the power rating of the snubber resistor. 7M



b) With the neat circuit diagram and waveforms , explain resistor triggering circuit 5.5M

*****GOOD LUCK******

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Time : 1½ Hour | Max. marks : 50

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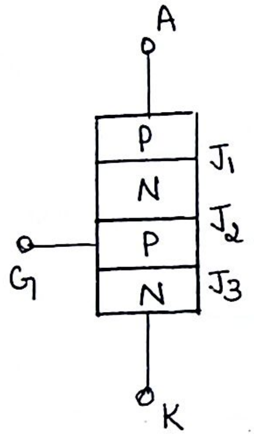
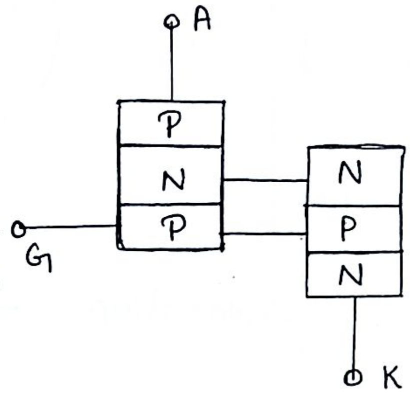
Note : *Answer any Two Full questions in each Part.*

Part-A

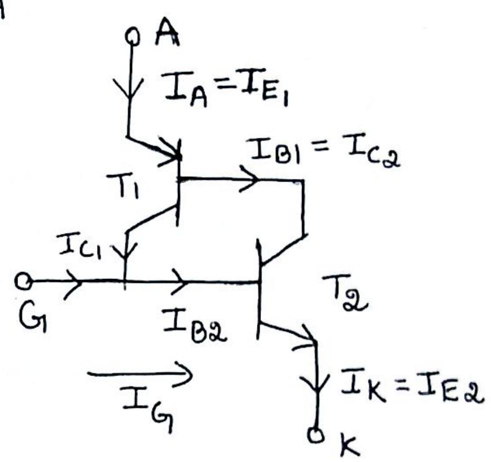
a)



Structure ↓ 1M



split section ↓ 1M



Two Transistor model of SCR ↓ 1.5M

$I_C = \alpha I_E + I_{CBO}$ .... (1) — 0.5M

Common base current gain, $\alpha \approx \frac{I_C}{I_E}$

For : T_1 , $I_{C_1} = \alpha_1 I_A + I_{CBO1}$ .... (2) — 0.5M

For T_2 , $I_{C_2} = \alpha_2 I_K + I_{CBO2}$ .... (3) — 0.5M

$I_K = I_A + I_G$ .... (4) — 0.5M

$I_{C_2} = \alpha_2 (I_A + I_G) + I_{CBO2}$ .... (5) — 0.5M

$I_A = I_{C_1} + I_{C2}$ — 0.5M

Adding eq (2) & (5)

$I_A = \alpha_1 I_A + I_{CBO1} + \alpha_2 (I_A + I_G) + I_{CBO2}$

$I_A[1 - (\alpha_1 + \alpha_2)] = \alpha_2 I_G + I_{CBO1} + I_{CBO2}$ — 1M

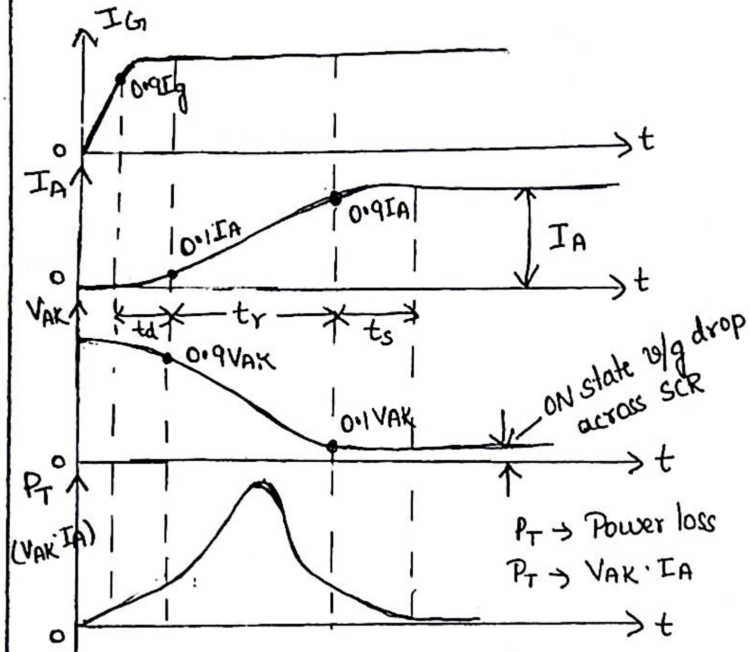
$I_A = \frac{\alpha_2 I_G + (I_{CBO1} + I_{CBO2})}{[1 - (\alpha_1 + \alpha_2)]}$

Total Marks → 7.5

b) Difference b/w Natural & Forced Commutation — 5M

Total → 5 Marks

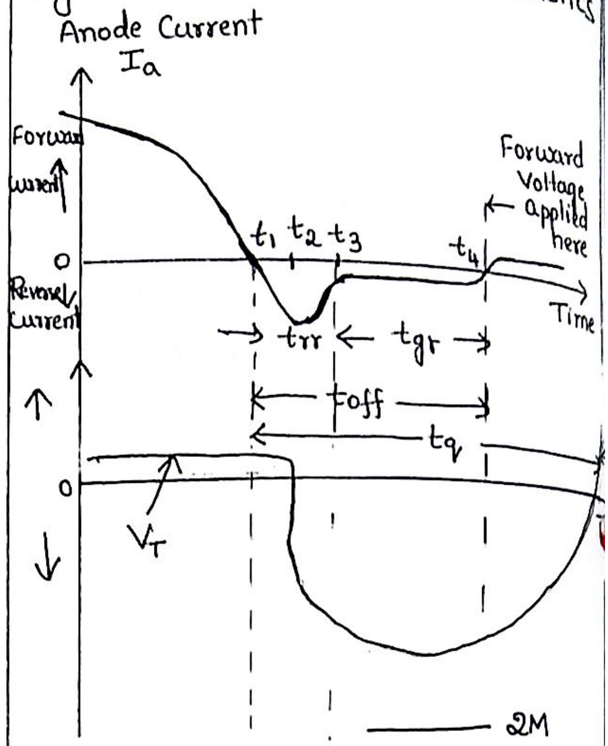
1a) Dynamic Turn-ON Characteristics



— 2M

Explanation — 2M

Dynamic Turn-OFF Characteristics



— 2M

Explanation — 2M

Total → 8 Marks

2b) Solution

Value of Capacitor is given by $C = \frac{I_o t_{off}}{E_{dc}}$ — 0.5M

Since there is 50% tolerance on turn off time

$$C = \frac{I_o(t_{off} + \Delta t_{off})}{E_{dc}} \quad \text{— 1M}$$

$$= \frac{40(40\times10^{-6} + 0.5\times40\times10^{-6})}{100}$$

$$= \underline{\underline{24\mu F}} \quad \text{— 1M}$$

Inductor Value

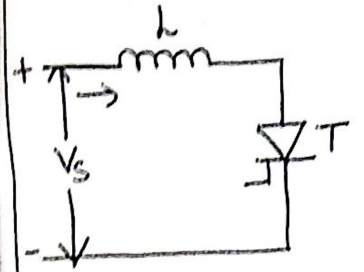
$$L = \left[\frac{E_{dc}}{I_o}\right]^2 C \quad \text{— 1M}$$

$$= \left[\frac{100}{40}\right]^2 \times 24\times10^{-6}$$

$$= \underline{\underline{0.15 mH}} \quad \text{— 1M}$$

Total → 4.5 Marks

$\frac{di}{dt}$ Protection

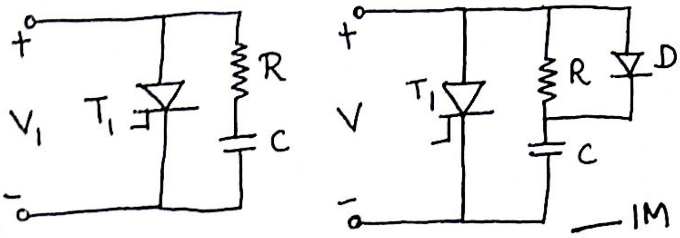


— 1M

$$L_s \geq \frac{V_s}{\frac{di}{dt}} \quad \left[V_s = L_s \frac{di}{dt} \qquad \frac{di}{dt} = \frac{V_s}{L_s} \right]$$ — 0.5M

Explanation — 1M

$\frac{dv}{dt}$ Protection



— 1M

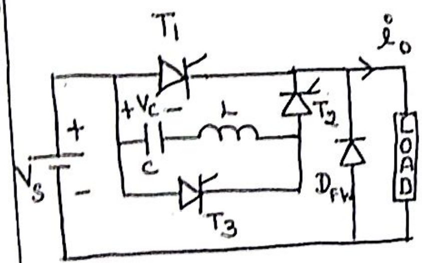
$$C = \frac{1}{2L}\left[\frac{0.564 V_m}{\frac{dv}{dt}}\right]^2$$ — 1M

$$R = 2\sigma\sqrt{\frac{L}{C}}$$

Explanation — 1M

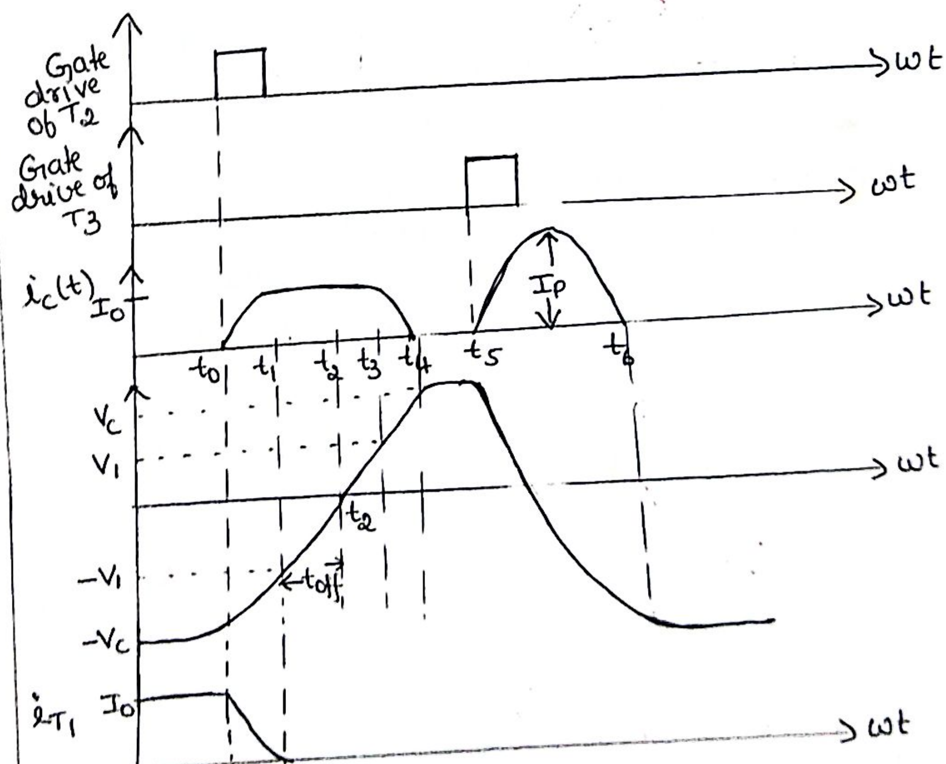
Total → 5.5 Marks

3b)



— 1.5M

Explanation — 2.5M

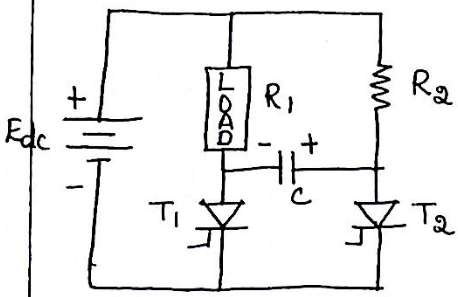


— 3M

Total → 7 Marks

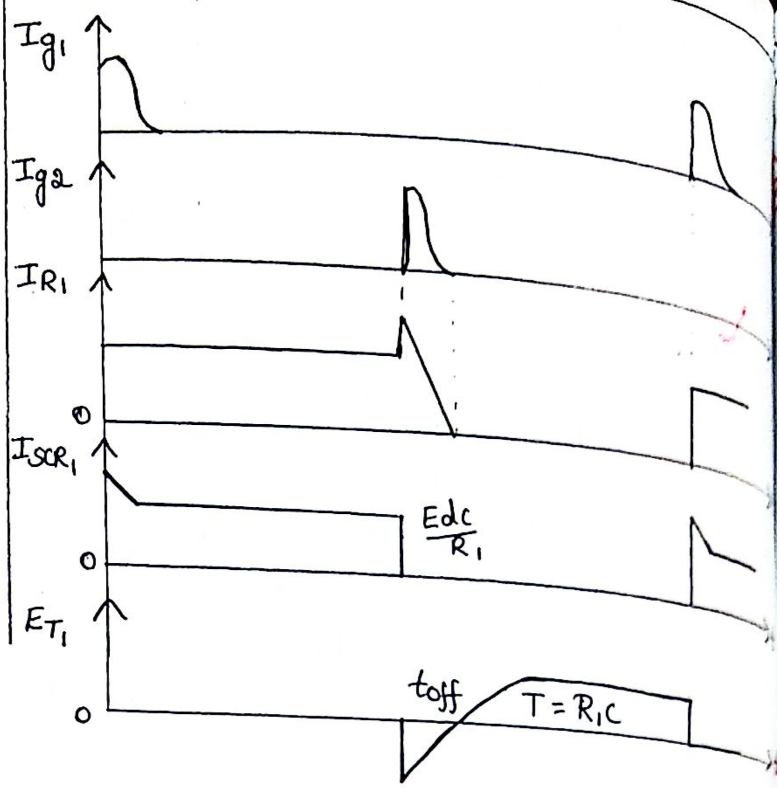
Part B

4a)



— 2M

Explanation — 3M



— 3M

Total → 8Marks

b) Conditions for Successful turn off — 4.5M

Total → 4.5Marks

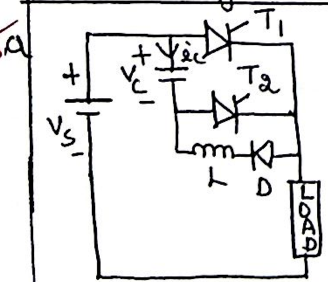
(i) A-K current of SCR must be reduced below I_H Value

(ii) As long as SCR turns-off, A-K voltage must be reversed.

(iii) The rate of change of anode - Cathode Voltage must be less than $\frac{dv}{dt}$ rating of SCR to avoid retriggering.

(iv) Above Conditions must be imposed till the SCR regains its forward blocking Voltage Capability.

5a)

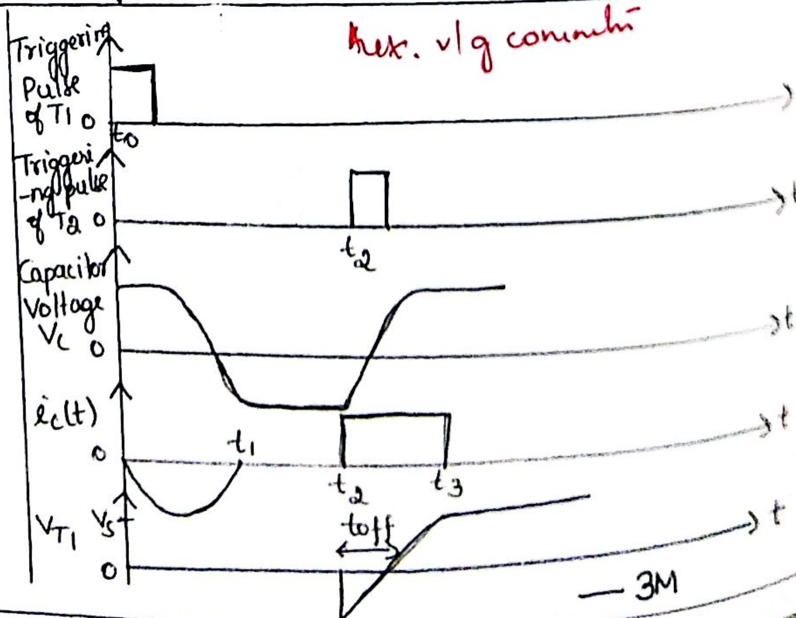


— 2M

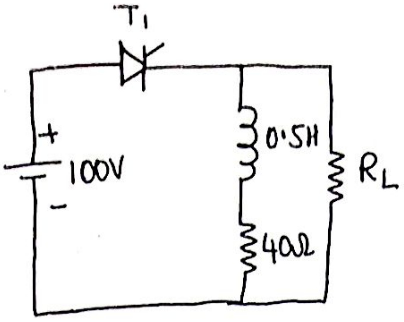
Explanation — 3M

Total → 8Marks

Ker. v/g commutn



— 3M



$$i(t) = \frac{V_s}{R}\left(1 - e^{-tR/L}\right) \quad \text{—— 1M}$$

$$= \frac{100}{40}\left(1 - e^{-\frac{50\times10^{-6}\times40}{0.5}}\right)$$

$$i(t) = 10mA < 50mA \quad \text{—— 1M}$$

Hence thyristor fails to remain ON when the gating pulse ends. —— 0.5M

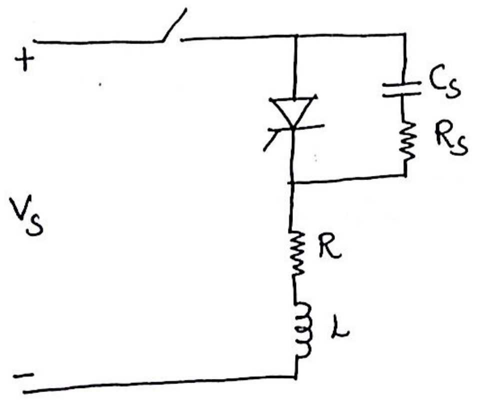
Maximum value of $R_L = \frac{V_s}{I}$ —— 1M

$$= \frac{100}{40\times10^{-3}}$$

$$= 2.5k\Omega \quad \text{—— 1M}$$

Total → 4.5 Marks

5a)



(a) $\frac{dv}{dt} = \frac{0.632 R V_s}{C_s (R_s + R)^2}$ —— 1M

$R_s = \frac{V_s}{I_D} = R_s = \frac{200}{100}$ —— 1M

$= 2\Omega$ —— 0.5M

$$100\times10^{-6} = \frac{0.632\times5\times200}{C_s(2+5)^2}$$

$C_s = 0.129\mu F$ —— 1M

(b) Snubber loss $P_s = 0.5 C_s V_s^2 f_s$ —— 1M

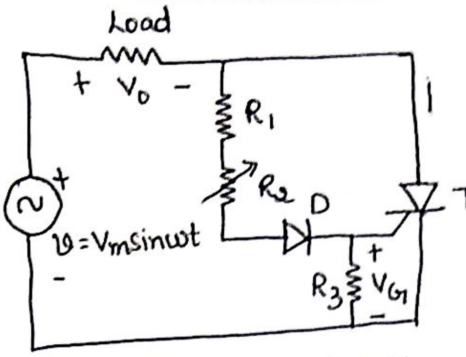
$$= 0.5(200)^2\times0.129\times10^{-6}\times2\times10^3$$

$= 5.2W$ —— 1M

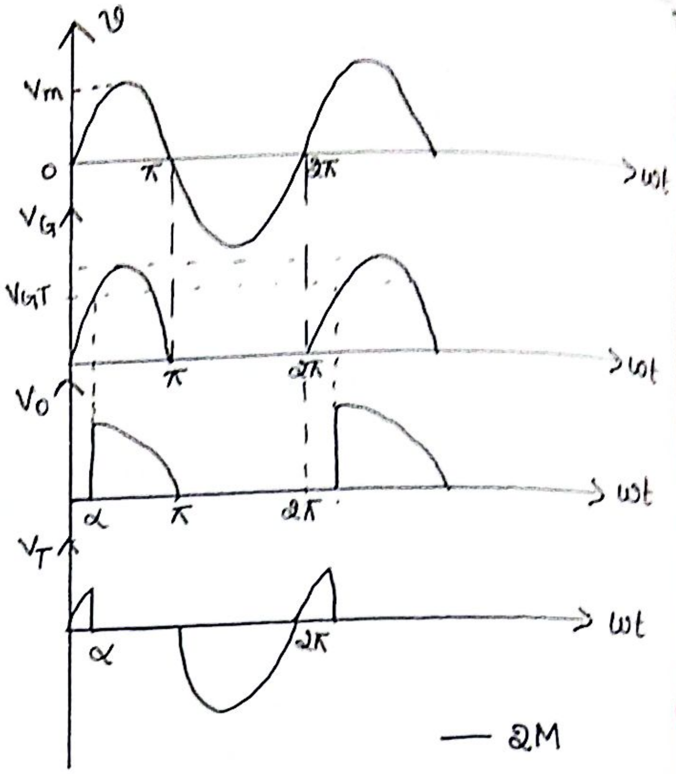
(c) Assuming that all the energy stored in C_s is dissipated in R_s only, the power rating of the snubber resistor is 5.2 W —— 1.5M

Total → 7 Marks

6b Resistance firing circuit (R-firing):



— 1.5 M



Explanation —— 2M

— 2M

Total → 5.5 Marks

D.V. [illegible]
24/10/16.