


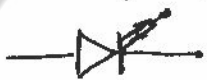
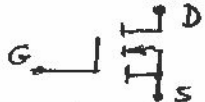
Name(in Arabic)

Student No.

Section

Programmable calculators are not allowed.
Derive any formula you use.

1. Answer the following by marking \checkmark for correct answer and X for wrong answer
3marks (each question 0.5 mark)

	Full Name	Symbol
SCR	Silicon Controlled Rectifier	
GTO	Gate turn off thyristor	
MOSFET	Metal Oxide Semiconductor field effect transistor	

2. Fig 1 shows the diode recovery characteristics of certain diode. 1mark

$$\text{Softness factor} = \frac{t_b}{t_a} = \frac{1.5}{0.5} = 3$$

3. Fig 2 shows the characteristics of two diodes connected in series with a total reverse voltage of 5kV. 2marks

Find the values of the equalizing resistances needed to get equal voltage drop across the two diodes and to have a total reverse current of 10mA.

$$V_{D1} = V_{D2} = \frac{5000}{2} = 2500 \text{ V}$$

$$R_1 = [833] \text{ k}\Omega$$

$$R_2 = [385] \text{ k}\Omega$$

$$\text{At } 2500 \text{ V } I_{D1} = 7 \text{ mA}$$

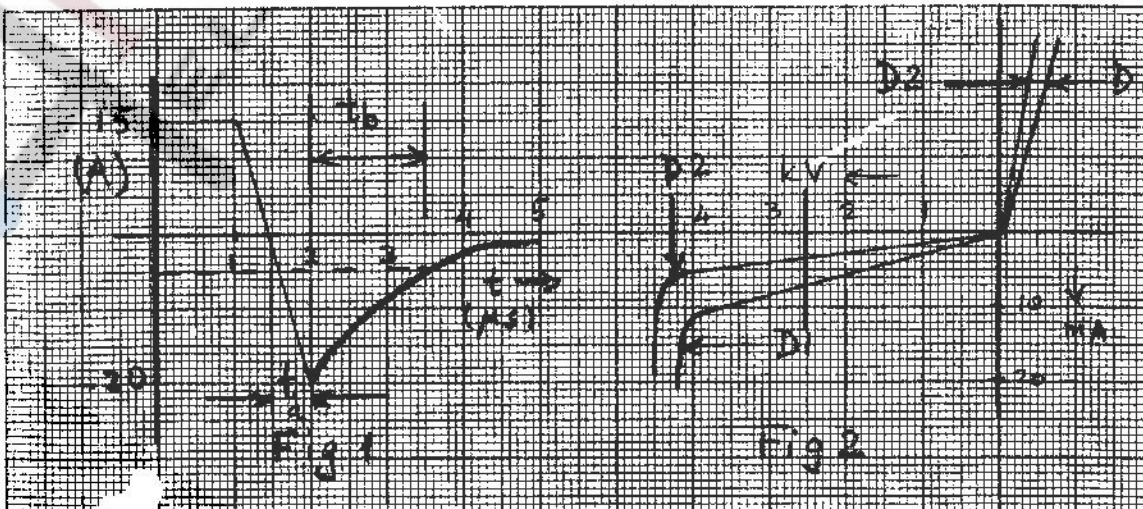
$$I_{D2} = 3.5 \text{ mA}$$

$$\therefore I_{R1} = 10 - 7 = 3 \text{ mA}$$

$$\therefore R_1 = \frac{2500}{3 \times 10^{-3}} = 833 \text{ k}\Omega$$

$$I_{R2} = 10 - 3.5 = 6.5 \text{ mA}$$

$$R_2 = \frac{2500}{6.5 \times 10^{-3}} = 385 \text{ k}\Omega$$



4. A voltage source $v(t) = 300 \sin(2\pi \times 50t + \pi/6)$ is applied to a non linear load drawing a current of $i(t) =$

$$20 \sin(2\pi \times 50t) + 8 \sin(2\pi \times 100t) + 6 \cos(2\pi \times 100t) \text{ A}$$

Find

4marks

(i) The power factor

[0.7745]

$$V_{\text{rms}} = \frac{300}{\sqrt{2}} = 212.16 \text{ V}$$

$$I_{\text{rms}} = \sqrt{\left(\frac{20}{\sqrt{2}}\right)^2 + \left(\frac{8}{\sqrt{2}}\right)^2 + \left(\frac{6}{\sqrt{2}}\right)^2} = 15.81 \text{ A}$$

$$\text{P.F} = \frac{P}{VI} = \frac{212.16 \times \frac{20}{\sqrt{2}} \times \cos \frac{\pi}{6}}{212.16 \times 15.81} = 0.7745$$

(ii) The displacement factor

$$\frac{212.16 \times 15.81}{212.16 \times 15.81}$$

[0.866]

$$\cos \phi_1 = \cos 30^\circ = 0.866$$

(iii) The distortion VA

[1500 VA]

$$P = \frac{20}{\sqrt{2}} \times \frac{300}{\sqrt{2}} \times \frac{\sqrt{3}}{2} = 2600 \text{ W}$$

$$Q = \frac{20}{\sqrt{3}} \times \frac{300}{\sqrt{2}} \times \frac{1}{2} = 1500 \text{ W}$$

$$D = \sqrt{\left(\frac{8}{\sqrt{2}}\right)^2 + \left(\frac{6}{\sqrt{2}}\right)^2} \times \frac{300}{\sqrt{2}} = 1500 \text{ (VA)}$$

(iv) The total harmonic distortion

[0.5]

$$\text{THD} = \sqrt{\frac{\left(\frac{10}{\sqrt{2}}\right)^2}{\left(\frac{20}{\sqrt{2}}\right)^2}} = \frac{1}{2}$$

5. A single phase half wave rectifier with an RL load and a freewheeling diode.
 $V_m = 200V$, $R = 10 \Omega$, $L = 0.05H$, $f = 50Hz$.

Find

- (i) The dc output current

5marks

[6.366] A

$$I_{dc} = \frac{1}{\pi R} \int_0^{\pi} V_m \sin \omega t d\omega t = \frac{V_m}{\pi R} = \frac{200}{10\pi} = 6.366 A$$

$$f(t) = \frac{V_m}{\pi R} + \frac{V_m}{2R} \sin \omega t - \frac{2V_m}{R\pi} \sum_{n=1}^{\infty} \frac{\cos 2n\omega t}{4n^2 - 1}$$

- (ii) The rms output current

[7.468] A

- (iii) The output power

[557.7] W

- (iv) The supply power factor

[0.528] lagging

n	V_n	Z_n	I_{nmax}	I_{nrms}
0	63.66	10	6.366	6.366
1	$\frac{200}{2} = 100$	$\sqrt{10^2 + (2\pi \times 50 \times 0.05)^2} = 18.62$	5.37	3.797
2	$\frac{2 \times 200}{3\pi}$	$\sqrt{10^2 + (2\pi \times 100 \times 0.05)^2} = 32.97$	1.287	0.91
4	$\frac{2 \times 200}{15\pi}$	$\sqrt{10^2 + (2\pi \times 200 \times 0.05)^2} = 63.62$	0.133	0.094

$$I_{rms} = \sqrt{6.366^2 + 3.797^2 + 0.91^2 + 0.094^2} = 7.468 A$$

$$P = 7.468^2 \times 10 = 557.7 W$$

$$PF = \frac{557.7}{\frac{200}{\sqrt{2}} \times 7.468} = 0.528 \text{ lagging}$$

6. A single phase half wave rectifier with a resistive load and a smoothing capacitor. $V_m = 200V$, $R = 1 k\Omega$. The output voltage, the capacitor current and the diode current are shown below.

6marks

Find the following

- (i) Value of the angle θ in degrees [99°]
 (ii) Value of the angle α in degrees [27°]
 (iii) The value of the capacitor needed to achieve these waveforms [$20.1 \mu f$]
 (iv) The maximum and minimum values of the capacitor currents
 $I_{cmax} = [1.125] A$
 $I_{cmin} = [-0.198] A$
 (v) The maximum value of the diode current [$1.216 A$]
 (vi) The output voltage ripple. [$109.2 V$]

$$\theta = \frac{5.5 \times 10^{-3}}{20 \times 10^{-3}} \times 360 = 99^\circ$$

$$= 99 \times \frac{2\pi}{360} = 1.728 \text{ rad}$$

$$f = 50 \text{ Hz}$$

$$\alpha = \frac{1.5 \times 10^{-3}}{20 \times 10^{-3}} \times 360 = 27^\circ$$

$$= 27 \times \frac{2\pi}{360} = 0.471 \text{ rad}$$

$$\theta = \pi - \tan^{-1}(\omega RC) = 99^\circ \quad 81 = \tan^{-1} \omega RC$$

$$\omega RC = 6.31375$$

$$C = \frac{6.31375}{2\pi \times 50}$$

$$= 20.1 \mu f$$

$$i_c = C \frac{dv}{dt} = C \frac{d}{dt} (V_m \sin \omega t)$$

$$= C V_m \omega \cos \omega t$$

$$= 20.1 \times 10^{-6} \times 200 \times 2\pi \times 50 \cos \omega t$$

$$= 1.293 \cos \omega t$$

$$I_{cmax} = 1.293 \cos 27^\circ$$

$$= 1.125$$

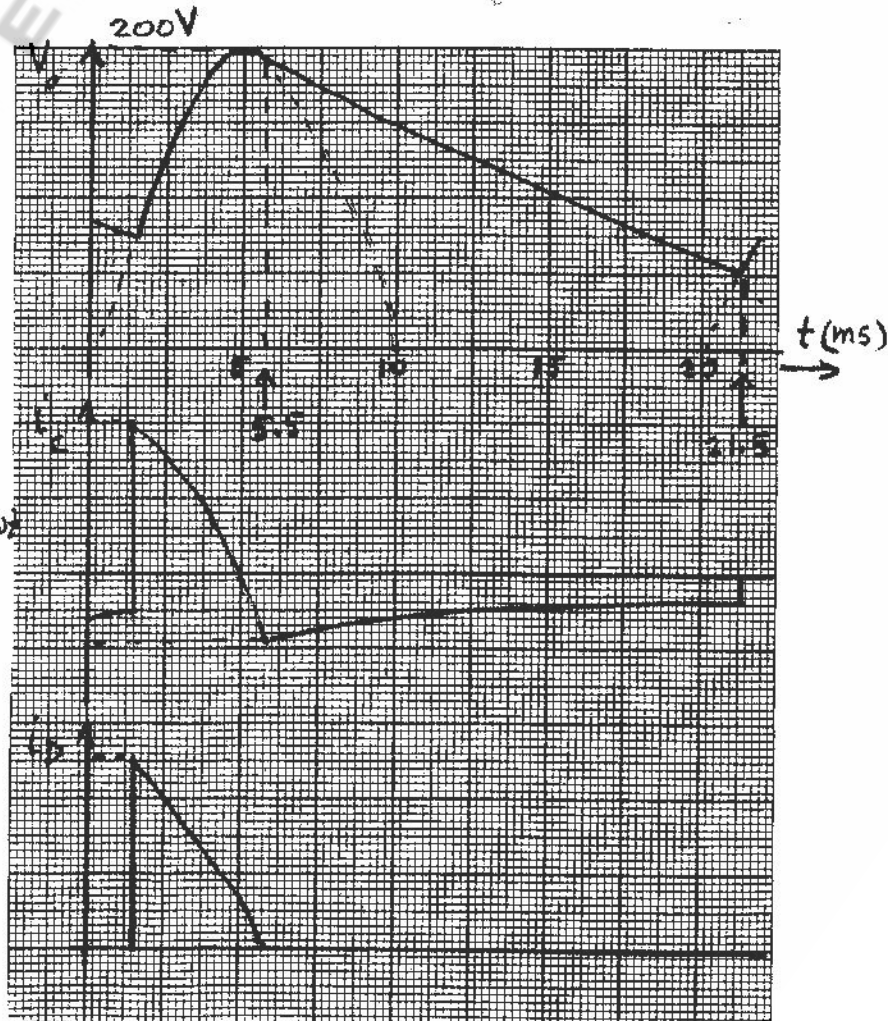
$$I_{cmin} = 1.293 \cos 99^\circ$$

$$= -0.198$$

$$i_D = i_c + i_R$$

$$= 1.293 \cos \omega t + \frac{200 \sin \omega t}{1000}$$

$$I_{Dmax} = 1.293 \cos \alpha + 0.2 \sin \alpha = 1.216 A$$



$$\Delta V = 200 - 200 \sin^4 27$$

$$= 109.2 V$$