– Marks distribution –

Q.1 – a – Circuit diagram – 2M
Explanation – 3M

b – Structural diagram – 2M
Operation – 3M

c – Diagram – 1M
Explanation – 4M

d – 1 Mark for each Comparison

e – Circuit diagram – 1M
Explanation – 1M
wave forms – 3M

Q.2 – a – Structure characteristics – 5M
Static char. – 5M

b – circuit diagram – 2M
Explanation – 3M
input & output waveforms – 3M
Formulas / derivation / Application – 2M

Q.3 a – circuit diagram – 3M
working – 4M
waveform – 3M

b – circuit diagram – 2M
Calculation – 2M
working – 2M
waveforms – 4M

Q-4 - a- Multiple PWM - 5M
Sinusoidal PWM - 5M

b- Average output voltage - 2.5M
ΔV_c - 2.5M
ΔI - 2.5M
Critical L & C - 2.5M

Q.5 - a- * Unidirectional
→ circuit diagram - 1.5M
→ working - 1.5M
→ waveforms - 2M

* Bidirectional
→ circuit diagram - 1.5M
→ working - 1.5M
→ waveforms - 2M

b- * class C [5M], class D [5M]
circuit diagram - 1.5M
working - 1.5M
waveforms - 2M

Q.6 - a. efficiency - 3.5M
Form factor - 3.5M
Power factor - 3M

b- 5M

c- circuit diagram - 1.5M
working - 1.5M
waveforms - 2M

Q. 4- b- $V_s = 14V$, $\alpha = 0.25$, $f = 25KHz$, $L = 160\mu H$

$c = 200\mu F$, $I_o = 1.25A$

$V_s \rightarrow$ Source voltage, $\alpha \rightarrow$ duty cycle

$f \rightarrow$ frequency, $L \rightarrow$ inductor, $C \rightarrow$ Capacitor

$I_o \rightarrow$ Average load current

(i) Average output voltage (V_o)

$$V_o = -V_s \cdot \frac{\alpha}{1-\alpha} = -14 \times \frac{0.25}{(1-0.25)}$$

$$V_o = -4.66V$$

(ii) Peak to peak output voltage ripple (ΔV_c)

$$\Delta V_c = \frac{I_o \cdot \alpha}{f \cdot C} = \frac{1.25 \times 0.25}{20 \times 10^3 \times 160 \times 10^{-6}}$$

$$\Delta V_c = 0.077 V.$$

(iii) Peak to peak ripple current of inductor (ΔI)

$$\Delta I = \frac{V_s \cdot \alpha}{f \cdot L} = \frac{14 \times 0.25}{25 \times 10^3 \times 160 \times 10^{-6}}$$

$$\Delta I = 0.87A$$

(iv) critical value of L and C

Load resistance (R) $\Rightarrow R = \frac{V_o}{I_o} = \frac{4.66}{1.25}$

$$R = 3.73\Omega.$$

$$L = \frac{\alpha(1-\alpha)R}{2f} = \frac{0.25(1-0.25)3.73}{2 \times 25 \times 10^3}$$

$$L = 13.9\mu H$$

$$c = \frac{\alpha}{2fR} = \frac{0.25}{2 \times 25 \times 10^3 \times 3.73} \Rightarrow C = 1.34\mu F$$

Q.6 - (a) $V_s = 230\,V$, $f = 50\,Hz$, $R = 10\Omega$, $\alpha = 45°$

$V_s \Rightarrow$ Source Voltage, $f \rightarrow$ frequency

$R \Rightarrow$ Load Resistance, $\alpha \Rightarrow$ Firing Angle

(i) Rectification efficiency (η)

$$\eta = \frac{\text{Output power}}{\text{Input power}} = \frac{V_o \cdot I_o}{V_{or} \cdot I_{or}}$$

$$\because V_o = \frac{2V_m}{\pi}\cos\alpha = \frac{2\sqrt{2}\times 230}{\pi}\cos 45° = 146.42V$$

$$I_o = \frac{V_o}{R} = \frac{146.42}{10} = 14.64A$$

$$V_{or} = V_s = 230V$$

$$I_{or} = I_o = 14.64\,A$$

$$\eta = \frac{146.42 \times 14.64}{230 \times 14.64} = 0.6366 = 63.66\%$$

(ii) Form Factor (FF)

$$FF = \frac{V_{or}}{V_o} = \frac{230}{146.42} = 1.57$$

(iii) Input Power Factor (PF)

PF = C.DF (current distortion factor) $\times$ DF (input distortion factor)

$$= \frac{2\sqrt{2}}{\pi}\cos\alpha = \frac{2\sqrt{2}}{\pi}\cos 45°$$

$$PF = 0.63$$