Problem 9-2

Half-bridge, $V_d = 155V$, $f_s = 100$ kHz, $V_o = 5V$, $I_o = 20A$

(a) DCM: $V_{oN} = 0.9$, $\omega_s = 0.45\ \omega_o$.

From Fig. 9-15 in DCM: $I_{oN} = 0.57$ (at $V_{oN} = 0.9$ and $\omega_{sN} = 0.45$).
Transformer turns ratio n:

$$\frac{nV_o}{\frac{V_d}{2}} = V_{oN} = 0.9$$

$$\therefore\ n = \frac{0.9 \times 155/2}{5.0} = 13.95$$

$$I_{o,pri} = \frac{I_o}{n} = \frac{20}{13.95} = 1.43A$$

$$I_{base} = \frac{V_d/2}{Z_o} = \frac{77.5}{Z_o}$$

$$\therefore\ I_{oN} = \frac{I_{o,pri}}{I_{base}} = \frac{1.43}{\frac{77.5}{Z_o}} = 0.57 \text{ (obtained above)}$$

$$I_{oN} = \frac{Z_o \times 1.43}{77.5} = 0.57$$

$$\therefore\ Z_o = \sqrt{\frac{L_r}{C_r}} = 30.89\Omega$$

$$\omega_s = 2\pi \times 100 \times 10^3 = 628.32 \times 10^3 \text{ rad/s}$$

$$\omega_{oN} = \frac{\omega_s}{\omega_o} = 0.45$$

$$\therefore\ \omega_o = \frac{1}{\sqrt{L_r C_r}} = \frac{628.32 \cdot 10^3}{0.45} = 1396.3 \cdot 10^3 \text{ rad/s}$$

$$\therefore\ L_r = \frac{Z_o}{\omega_o} = \frac{30.89}{1396.3 \cdot 10^3} = \boxed{22.12\ \mu H}$$

$$C_r = \frac{L_r}{Z_o^2} = \frac{22.12 \cdot 10^{-6}}{30.89^2} = \boxed{23.18\ nF}$$

(b) $$I_{base} = \frac{V_d/2}{Z_o} = \frac{77.5}{30.89} = 2.51A$$

From problem 9-1

$$I_{L,peak} = [1+(V_o)_N] \cdot I_{base} = (1 + 0.9) \cdot 2.51 = 4.77A$$

$$V_{c,peak} = 2V_{base} = 2 \cdot \frac{155}{2} = 155V$$

$$\therefore\ S = (\frac{1}{2} \cdot 22.12 \cdot 10^{-6} \cdot 4.77^2) + (\frac{1}{2} \cdot 23.18 \cdot 10^{-9} \cdot 155^2)$$

$$= 10^{-6} \cdot (251.6 + 278.4) = 530.0\ \mu J$$