Problem 5-2

V_s = 220 V, R = 10 Ω, L = 15.5 mH, E = 20 V, k = 0.5 and f = 5000 Hz

From Eq. (5-15), $I_2 = 0.9375\ I_1 + 1.2496$

From Eq. (5-16), $I_1 = 0.9375\ I_2 - 1.2496$

(a) Solving these two equations, I_1 = 8.6453 A

(b) I_2 = 9.3547 A

(c) $\Delta I = I_2 - I_1 = 9.35475 - 8.6453 = 0.7094$ A

From Eq. (5-21), $\Delta I_{max} = 0.7094$ A

and Eq. (5-22) gives the approximately value, $\Delta I_{max} = 0.7097$ A

(d) The average load current is approximately,

$I_a = (I_2 + I_1)/2 = (9.35475 + 8.6453)/2 = 9$ A

(e) From Eq. (5-24),

$$I_o = \left[I_1^2 + \frac{(I_2 - I_1)^2}{3} + I_1(I_2 - I_1) \right]^{1/2} = 9.002 \text{ A}$$

(f) $I_s = k\ I_a = 0.8 \times 9 = 7.2$ A

and the input resistance is $R_i = V_s/I_s = 220/7.2 = 30.56$ Ω

(g) From Eq. (5-25), $I_R = \sqrt{k}\ I_o = \sqrt{0.8} \times 22.1 = 15.63$ A

Problem 5-3

V_s = 220 V, R = 0.2 Ω, E = 10 V, f = 200 Hz, T = 1/f = 0.005 s

$\Delta i = 200 \times 0.5 = 10$ A.

$V_a = k\ V_s = R\ I_a$

The voltage across the inductor is given by

$$L\frac{di}{dt} = V_S - RI_a = V_S - kV_S = (1-k)V_S$$

For a linear rise of current, dt = t_1 = kT and di = Δi

$$\Delta i = \frac{(1-k)V_S}{L} kT$$

For worst case ripple condition: $\frac{d(\Delta i)}{dk} = 0$

and this gives, k = 0.5

$\Delta i\ L = 10 \times L = 220\ (1 - 0.5)\ 0.5 \times 0.005$ or L = 27.5 mH

Problem 5-4

V_s = 110 V, E = 220 V, P_o = 30 kW = 30000 W

(c) Since the input power must be the same as the output power,

$V_s I_s = P_o$ or 110 x I_s = 30000 or I_s = A

(a) The battery current, $I_b = P_o/E$ = 30000/220 = 136.36 A

$I_b = (1 - k) I_s$ or k = 136.36/272.73 - 1 = 0.5

(b) $R_{ch} = (1 - k) E/I_s$ = 1 - 0.5) x 220/272.73 = 0.4033 Ω

Problem 5-6

V_s = 600 V, R = 0.25 Ω, L = 20 mH, E = 150 V, k = 0.1 to 0.9 and f = 250 Hz

For k=0.1, the load current is discontinuous

From Eq. (5-15), I_2 = 8.977

From Eq. (5-16), I_1 = 0, ΔI = 8.977 A and I_a = 4.4885 A

For k=0.2, the load current is discontinuous

I_2 = 17.9103 A, I_1 = 0 A, ΔI = 17.9103 A and I_a = 8.955 A

For k = 0.3

$I_2 = 0.9851 I_1 + 26.7985$, $I_1 = 0.9656 I_2 - 20.6367$

I_2 = 132.64 A, I_1 = 107.44 A, ΔI = 25.2 A and I_a = 120.04 A

For k = 0.4

$I_2 = 0.9802 I_1 + 35.64$, $I_1 = 0.97044 I_2 - 17.733$

I_2 = 374.42 A, I_1 = 345.62 A, ΔI = 28.8 A and I_a = 360.02 A

For k = 0.5

$I_2 = 0.9753 I_1 + 44.44$, $I_1 = 0.97045 I_2 - 14.814$

I_2 = 615 A, I_1 = 585 A, ΔI = 30 A and I_a = 600 A

For k = 0.6

$I_2 = 0.97044 I_1 + 53.2$, $I_1 = 0.9802 I_2 - 11.881$

I_2 = 854.38 A, I_1 = 825.58 A, ΔI = 28.8 A and I_a = 840 A

For k = 0.7

$I_2 = 0.9656 I_1 + 61.91$, $I_1 = 0.9851 I_2 - 8.933$

I_2 = 1092.6 A, I_1 = 1067.4 A, ΔI = 25.2 A and I_a = 1080 A

For k = 0.8

$I_2 = 0.9608 I_1 + 70.58$, $I_1 = 0.99 I_2 - 5.97$

I_2 = 1329.6 A, I_1 = 1310.4 A, ΔI = 19.2 A and I_a = 1320 A

For k = 0.9

$I_2 = 0.956 I_1 + 79.2$, $I_1 = 0.995 I_2 - 2.99$

I_2 = 1565.4 A, I_1 = 1554.6 A, ΔI = 10.8 A and I_a = 1560 A