Problem 10-1

$R = 10\ \Omega$, $\alpha = \pi/3$, $V_s = 120$ V, $V_m = \sqrt{2} \times 120 = 169.7$ V

From Eq. (10-1), $V_{dc} = 0.2387\ V_m$ and $I_{dc} = 0.2387\ V_m/R$

From Eq. (10-4), $V_{rms} = 0.4485\ V_m$ and $I_{rms} = 0.4485\ V_m/R$

From Eq. (3-1), $P_{dc} = V_{dc}\ I_{dc} = (0.2387\ V_m)^2/R$

From Eq. (3-2), $P_{ac} = V_{rms}\ I_{rms} = (0.4485\ V_m)^2/R$

(a) From Eq. (3-3) the rectification efficiency,

$\eta = (0.2387\ V_m)^2/(0.4485\ V_m)^2 = 28.32\ \%$

(b) From Eq. (3-5) the form factor is, $FF = 0.4485\ V_m/(0.2387\ V_m) = 1.879$ or 187.9 %

(c) From Eq. (3-7) the ripple factor, $RF = [1.879^2 - 1]^{1/2} = 1.591$ or 159.1%

(d) The rms voltage of transformer secondary is $V_s = V_m/\sqrt{2} = 0.707\ V_m$

The rms value of the transformer secondary current is the same as that of the load, $I_s = 0.4485\ V_m/R$

Volt-Amp (VA) of transformer, $VA = V_s\ I_s = 0.707\ V_m \times 0.4485\ V_m/R$

From Eq. (3-8) $TUF = 0.2387^2/(0.707 \times 0.4485) = 0.1797$ and $1/TUF = 5.56$

(e) The peak inverse voltage, $PIV = V_m = 169.7$ V

Problem 10-2

$R = 10\ \Omega$, $V_s = 120$ V, $V_n = 0.25$ pu, $V_m = \sqrt{2} \times 120 = 169.7$ V

(a) From Eq. (10-3), $0.25 = 0.5\ (1 + \cos \alpha)$ or $\alpha = 120^\circ$

(b) From Eq. (10-1), $V_{dc} = 0.0796\ V_m = 13.5$ V, $I_{dc} = 13.5/10 = 1.35$ A

From Eq. (10-4), $V_{rms} = 0.221\ V_m = 37.5$ V, $I_{rms} = 37.5/10 = 3.75$ A

**Problem 10-7**

$V_s = 120$ V, f = 60 Hz, $\alpha = \pi/3$, $V_m = \sqrt{2} \times 120 = 169.7$ V

From Eq. (10-9), $I_1 = (2\sqrt{2}\ I_a/\pi) = 0.9003\ I_a$

$I_s = I_a$

(a) $HF = [(I_s/I_1)^2 - 1]^{1/2} = 0.4834$ or 48.34 %

(b) From Eq. (10-10), $\varphi_1 = -\pi/3$ and $DF = \cos(-\pi/3) = 0.5$

(c) $PF = (I_1/I_s)\ DF = (2\sqrt{2}/\pi) \times 0.5 = 0.45$ (lagging)

Problem 10-8

R = 10 Ω, $V_s$ = 120 V, $V_n$ = 0.25 pu, $V_m$ = √2 x 120 = 169.7 V

(a) From Eq. (10-6), 0.25 = cos α or α = 75.5°

(b) From Eq. (10-5), $V_{dc}$ = 0.1591 $V_m$ = 27 V, $I_{dc}$ = 27/10 = 2.7 A

From Eq. (10-7), $V_{rms}$ = 0.70 $V_m$ = 120 V, $I_{rms}$ = 120/10 = 12 A

(c) $I_{av}$ = $I_{dc}$ = 1.35 A, $I_R$ = $I_{rms}$ = 12/√2 = 8.49 A

(d) Assuming that the harmonics are negligible, the output power, $P_o$ = $12^2$ x 10 = 1440 W

The rms voltage of transformer secondary is $V_s$ = 120 V

The rms value of the transformer secondary current is the same as that of the load, $I_s$ = $I_{rms}$ = 12 A

Volt-Amp (VA) of transformer, VA = $V_s$ $I_s$ = 120 x 12 = 1440

pf = 1440/1440 = 1.0

Problem 10-22

α = 2π/3

From Eq. (10-29), $I_1$ = (√6/π) $I_a$ = 0.7797 $I_a$

$$I_s = \left[\frac{2}{2\pi}\int_{\pi/6+\alpha}^{5\pi/6+\alpha} I_a^2\, d\theta\right]^{1/2} = I_a\sqrt{\frac{2}{3}} = 0.8165\, I_a$$

(a) HF = $[(I_s/I_1)^2 - 1]^{1/2}$ = $[(\pi/3)^2 - 1]^{1/2}$ = 0.3108 or 31.08 %

(b) From Eq. (10-28), DF = cos (- α) = 0.5

PF = ($I_1/I_s$) x DF = (3/π) DF = 0.478 (lagging)

Problem 10-23

$V_L$ = 220 V, f = 60 Hz, R = 10 Ω, $V_s$ = 220/√3 = 127 V,

$V_m$ = √2 $V_s$ = 179.6 V, $V_n$ = 0.25 Ω

$V_{dm} = 3\sqrt{3}\, V_m/\pi = 3\sqrt{3} \times 179.6/\pi = 297$ V

$V_{dc} = 0.25 \times 297 = 74.26$ V

(a) From Eq. (10-26), $0.25 = \cos \alpha$, or $\alpha = 75.5°$

(b) $I_{dc} = V_{dc}/R = 74.26/10 = 7.426$ A

From Eq. (10-27),

$V_{rms} = 6 \times 179.6 [(1/4) + (3\sqrt{3}/8\pi) \cos (2 \times 75.5)]^{1/2} = 115.6$ V

$I_{rms} = 115.6/10 = 11.56$ A

(c) $I_{DT} = I_{dc}/3 = 7.426/3 = 2.48$ A

$I_{RT} = I_{rms}\sqrt{(2/6)} = 11.56\sqrt{(2/6)} = 6.67$ A

(d) From Eq. (3-3)

$\eta = 74.26 \times 7.426/(115.6 \times 11.56) = 0.4123$ or 41.23 %

(e) $I_s = I_{rms}\sqrt{(4/6)} = 9.44$ A,

$VI = 3\, V_s I_s = 3 \times 127 \times 9.44 = 3597$ W

From Eq. (3-8), TUF = $74.26 \times 7.426/3597 = 0.1533$

(f) The output power, $P_o = I_{rms}^2\, R = 11.562 \times 10 = 1337$ W

pf = 1337/3597 = 0.3717 (lagging)