Exercise No.5 with solution

Question 1:

The controlled full wave rectifier has 18 Ω resistive load and a 120 V-RMS 60 Hz source. The delay angle is 45 degrees. Find,

a) Average load current.

b) RMS load current.

c) RMS source current.

d) Power factor.

a) Average Load Current:

The average load current is given as,

$$i_{o\,(avg)} = \frac{V_{o\,(avg)}}{R} = \frac{V_m}{\pi R}(1 + cos \propto)$$

$$i_{o\,(avg)} = \frac{120\ x\ \sqrt{2}}{3.14\ x\ 18}(1 + \cos 45°) = 5.12\ A$$

b) RMS Load Current:

The RMS load current is given as,

$$i_{o\,(rms)} = \frac{V_m}{R}\sqrt{\frac{1}{2} - \frac{\propto}{2\pi} + \frac{\sin 2 \propto}{4\pi}}$$

$$i_{o\,(rms)} = \frac{120\ x\ \sqrt{2}}{18}\sqrt{\frac{1}{2} - \frac{0.785}{2\pi} + \frac{\sin 2x0.785}{4\pi}}$$ $\propto = 45\,° = 0.785$ rad

$$i_{o\,(rms)} = 6.35\ A$$

c) RMS Source Current:

We know that input and output RMS currents are same,

$$i_{in\,(rms)} = i_{o\,(rms)} = 6.35\ A$$

d) Power Factor:

We have,

$$PF = \frac{P}{S} = \frac{i^2_{o(rms)}\ x\ R}{V_{in\,(rms)}\ x\ i_{in\,(rms)}}$$

$$PF = \frac{(6.35)^2 x\ 18}{120\ x\ 6.35}$$

$$PF = 0.95$$

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Question 2:

A load of 50 Ω is connected to an AC source of 60 Hz, 230 V-RMS. Full wave-controlled rectifier has a delay angle of 45 degrees. Calculate the average load current, power absorbed by the load, and the source VA.

For Average Load Current, we have

$$V_{o\,(avg)} = \frac{V_m}{\pi}(1 + cos \propto)$$

$$V_{o\,(avg)} = \frac{230\ x\ \sqrt{2}}{3.14}(1 + cos45) = 176.8\ V$$

So,

$$i_{o\,(avg)} = \frac{V_{o\,(avg)}}{R}$$

$$i_{o\,(avg)} = \frac{176.8}{50} = 3.53\ A$$

For Power Absorbed by Load, we have

$$P = i^2_{o\,(rms)}\ x\ R$$

where,

$$i_{o\,(rms)} = \frac{V_m}{R}\sqrt{\frac{1}{2} - \frac{\propto}{2\pi} + \frac{\sin 2 \propto}{4\pi}}$$

$$i_{o\,(rms)} = \frac{230\ x\ \sqrt{2}}{50}\sqrt{\frac{1}{2} - \frac{0.785}{2\pi} + \frac{\sin 2x0.785}{4\pi}} = 3.99\ A$$

So, we have the power absorbed,

$$P = (3.99)^2\ x\ 50 = 798.11\ W$$

For Source VA, we have,

$$S = V_{in\,(rms)}\ x\ i_{in\,(rms)}$$

$$S = 230\ x\ 3.99$$

$$S = 917.7\ VA$$

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