395.

<u>Problem 32.51 (RHK)</u>

An electron linear accelerator produces a pulsed beam of electrons. The pulse current is 485 mA *and the pulse duration is* 95.0 ns. (a) *We have to find the number of electrons in each pulse;* (b) *average current for a machine operating at* $520 \text{ pulses s}^{-1}$; *if the electrons are accelerated to an energy of* 47.7 MeV, *we have to find the values of the average and the peak power outputs of the accelerator.*

<u>Solution:</u>

(a)

In the linear accelerator the pulse current is 485 mA and the pulse duration is 95.0 ns. Therefore, the total charge contained in one pulse will be

$$q = 485\times10^{-3}\times95.0\times10^{-9} \text{ C} = 4.6075\times10^{-8} \text{ C}.$$

Charge of one electron is $e = 1.6\times10^{-18}$ C. Therefore, the number of electrons in one pulse will be

$$n = \frac{q}{e} = \frac{4.6075\times10^{-8}}{1.6\times10^{-19}} = 2.879\times10^{11}.$$

(b)

The average current for a machine operating at 520 pulses s^{-1} will be

$$i = 520q = 520 \times 4.6075 \times 10^{-8}\ \text{A} = 2.395 \times 10^{-5}\ \text{A} = 23.95\ \mu\text{A}.$$

(c)

The electrons are accelerated to an energy of $47.7\ \text{MeV}$. That is the accelerating potential is $47.7 \times 10^{6}\ \text{V}$. The average output power of the accelerator will, therefore, be

$$P_{average} = average\ current \times accelerating\ voltage$$

$$= 23.95 \times 10^{-6} \times 47.7 \times 10^{6}\ \text{W}$$

$$= 1.142\ \text{kW}.$$

(d)

The peak power of the accelerator will be

$$P_{peak} = pul\text{se}\ \text{c}urrent \times acceleating\ voltage$$

$$= 485 \times 10^{-3} \times 47.7 \times 10^{-6}\ \text{W}$$

$$= 23.13\ \text{MW}.$$