11.2) We have expected occupancy $= \dfrac{1}{1+e^{\left(\frac{E-E_F}{KT}\right)}}$

$$= \frac{1}{1+e^{\left(\frac{E_F+E_g}{(2-E_F)KT}\right)}} = \frac{1}{1+e^{\frac{E_g}{2KT}}}$$

For Germanium $= \dfrac{1}{1+e^{\frac{0.67eV}{2KT}}}$

$KT = 8.617\times10^{-5}\times300 = 0.026$ eV

For Germanium $= 2.5\times10^{-6}$

For Silicon $= 5.4\times10^{-10}$.

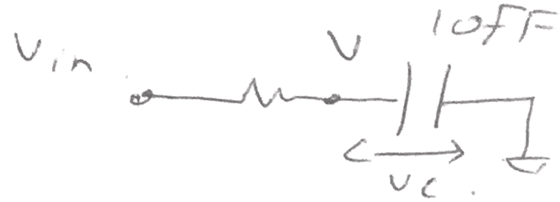
For diamond $= 1.7\times10^{-42}$.

11.5) a) Energy in capacitor $= \frac{1}{2}CV^2$

$$= \frac{1}{2} \times 10 \times 10^{-15} \times 5^2$$

$$= 1.25 \times 10^{-13}\,J$$

b)



$$i = \frac{V_{in} - V}{R} = C\frac{dV_c}{dt}$$

$$\frac{dV_c}{dt} = \frac{1}{RC}(V_{in} - V), \quad V = V_c$$

$$V_c = V\left(1 - e^{-t/RC}\right)$$

$$i = \frac{V}{R} e^{-t/RC}$$

$$\text{Power dissipated} = \int_0^\infty \frac{V^2}{R}\,dt = \int_0^\infty i^2 R\,dt$$

$$= \int_0^\infty \frac{V^2}{R^2} e^{-2t/RC} \cdot R\,dt = \frac{V^2}{R}\int_0^\infty e^{-\frac{2t}{RC}}\,dt$$

$$= \frac{V^2}{R}\left(\frac{1}{-\frac{2}{RC}}\right) e^{-2t/RC}\Big|_0^\infty = ~~\frac{2V^2}{R^2C}~~ = \frac{1}{2}CV^2$$

~~We have~~ $\frac{dV_c}{dt} = \frac{1}{RC}(V_{in} - V_c)$

(d) Energy stored in charging $= \frac{1}{2}CV^2$

Energy dissipated in discharging $= \frac{1}{2}CV^2$

Total energy $= CV^2 = 10\times10^{-15} \times 5^2 = 2.5\times10^{-13}$ J

Power $=$ 1W

$\therefore$ Frequency at which charge and discharge happens $= \frac{1}{2.5\times10^{-13}} =$

$= 40\times10^{11}$ Hz

$= 4\times10^{12}$ Hz

e) 2.5×10^{-13} J (per transistor) $\times$ 10^6 Transistor. $\times$ 100×10^6 $= 25$W

F) Charge in a capacitor $Q = CV$.

$= 10 \times 10^{-15} \times 5 = 5 \times 10^{-14}$ C.

No. of electrons $= \dfrac{5 \times 10^{-14}}{1.6 \times 10^{-19}} = 3 \times 10^{5}$ electrons