(1) The dielectric constant of pure water is 70. (a) Determine the Brewster angle for parallel polarization, $\theta_{B\parallel}$, and the corresponding angle of transmission. (b) A plane wave with perpendicular polarization is incident from air on water surface at $\theta_i = \theta_{B\parallel}$. Find the reflection and transmission coefficients. (20%)

(2) (a) Determine the mutual inductance between a very long straight wire and a conducting circular loop, as showin in Fig 1.
(b) A conducting circular loop of a radius 0.1(m) is situated in the neighborhood of a very long power line carrying a 60-(Hz) current, as shown in Fig 1, with $d = 0.15$(m). An AC millimeter inserted in the loop reads 0.4(mA). Assume the total impedance of the loop including the millimeter to be 0.02(Ω). Find the magnitude of the current in the power line. (30%)

(3) Using the principle of virtual displacement, derive an expression for the force between two point charges $+Q$ and $-Q$ separated by a distance x in free space. (10%)

(4) Electrons with energies of 2ev and 3ev are incident on a barrier 6ev high and 5Å wide. Find their respective transmission probabilities. How are these affected if the barrier is doubled in width? (10%)

(5) How many photons are presents in 1 cm^3 of radiation in thermal equilibrium at 1200°K? What is their average energy? (20%)

(6) Describle the principles of the formation of energy bands in the semiconductor. (10%)

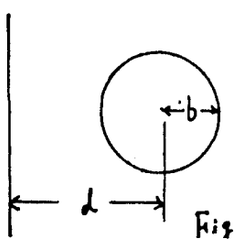

Fig. 1.

$\epsilon_0 = 8.85 \times 10^{-12}$ f/m
$\mu_0 = 4\pi \times 10^{-7}$ h/m
$K = 1.38 \times 10^{-23}$ J/K
$m_e = 9.1 \times 10^{-31}$ kg
$h = 6.625 \times 10^{-34}$ J. sec
$\int_0^\infty \frac{x^2 dx}{e^x - 1} = 2.405$