

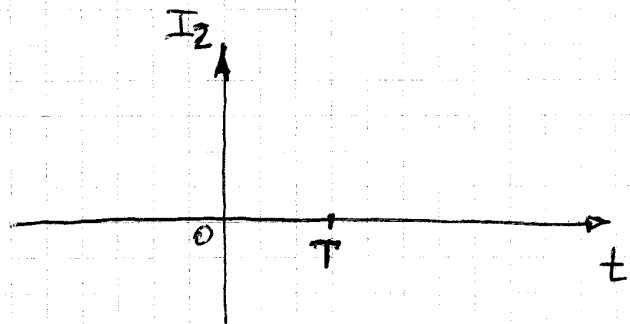
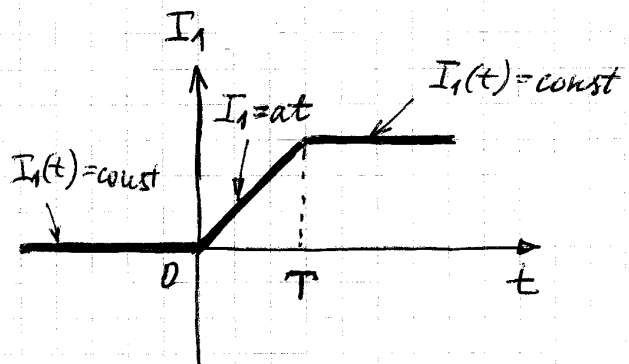
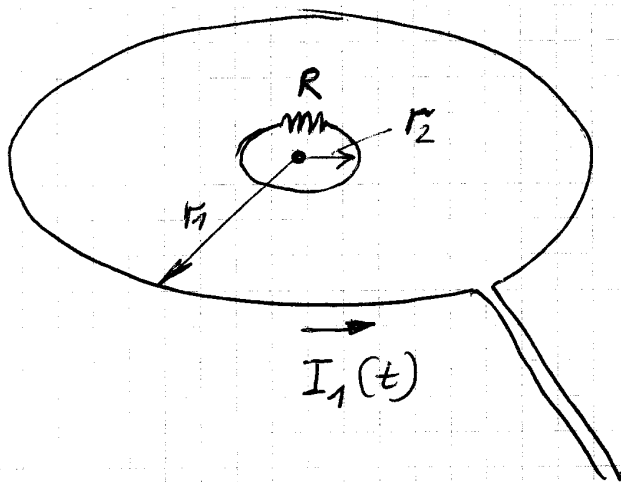
FINAL EXAM (total 100 points)

Electromagnetics (PHYS-4211)

1) (25 points) A loop of radius  $r_2=0.1\text{m}$  is placed in the centre of a larger loop  $r_1=1\text{m}$  such that they both lie in the same plane. At time  $t=0$  current  $I_1$  begins to flow in the larger loop. The current  $I_1(t)$  increases uniformly with time at the rate of  $a=10\text{A/s}$  for some time  $T$ . After that  $I_1(t)$  stabilizes.

- Determine the magnitude of e.m.f. induced in the smaller loop.
- What is the magnitude and direction of current in the smaller loop, provided it contains the resistor  $R=3\Omega$ .
- Plot the time evolution of the current in the smaller loop.

Note: You can neglect non-uniformity of the magnetic field within the smaller loop.



2) (25 points) A plane electromagnetic sinusoidal wave is travelling in the direction  $-\hat{x}$ ; its frequency is 100 MHz; the electric field is perpendicular to the  $\hat{z}$  direction.

- Write formulas for  $\vec{E}(t)$  and  $\vec{B}(t)$  that specify such a wave.
- Determine the wave length  $\lambda$ .
- Find the amplitudes  $E_0$  and  $B_0$  assuming that the power density carried by this electromagnetic radiation is  $100 \text{ W/m}^2$ .

3) (25 points) An electron with the initial kinetic energy of  $E_k = 10 \text{ keV}$  is brought to a complete stop as a result of uniform deceleration at the distance of  $20 \text{ \AA}$ .

- Determine the amount of electromagnetic energy emitted.
- What is the fraction of kinetic energy converted into the electromagnetic radiation?

*Note:* Neglect relativistic effects.

4) (25 points) Photons generated by a monochromatic light source incident the structure as shown on the figure (the distances represent the optical path length). The reflection probability at the glass/air interface equals 0.04.

- Determine the probability of light to be transmitted through the structure.
- Support your calculations by the arrow diagram.

Note: Neglect multiple reflections.

Hint: Transmitted photons are those, which are not reflected (sounds trivial, but it can be useful).

