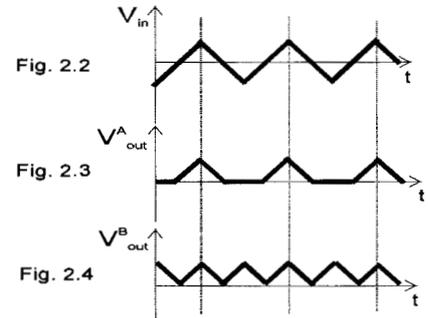
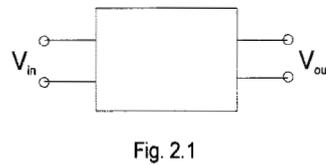


**Problem 1 (4 points)**

- 1.1 (1 point) What are the principal (base) units in International System of units (SI)?
- 1.2 (1 point) Derive dimensionality of the dielectric and magnetic constants of vacuum:  $\epsilon_0$  and  $\mu_0$ .
- 1.3 (2 points) How the unit of electric current (A) is defined in SI? What are the drawbacks of this definition?

**Problem 2 (5 points)**

A voltage  $V_{in}(t)$  (Fig. 2.2, solid lines) is applied to the inputs of a device, schematically represented by Fig. 2.1.



- 2.1 (2 points) Devise circuit providing output  $V_{out}(t)$  plotted in Fig. 2.3
- 2.2 (3 points) Devise circuit providing output  $V_{out}(t)$  plotted in Fig. 2.4

**Problem 3 (5 points)**

Electromagnetic wave is penetrating from the medium I with dielectric constant  $\epsilon_1$  at the angle  $\alpha_1 = 30^\circ$  into the medium II with constant  $\epsilon_2$  and propagate at the angle  $\alpha_2 = 60^\circ$  (Fig. 3).



Consider the magnetic permeability  $\mu$  is the same in both materials:  $\mu_1 = \mu_2$

- 3.1 (4 points) What is the relation between  $\epsilon_1$  and  $\epsilon_2$  ?
- 3.2 (1 point) If medium I is vacuum, what is the speed of light in medium II?

Fig. 3

**Problem 4 (6 points)**

AC voltage  $V_{in} = V_o \sin(\omega t)$  is provided to the input of the circuit (Fig. 4).

- 4.1 (1 point) Draw the dependence of the normalized output voltage  $|V_{out} / V_{in}|$  on the frequency of the input signal  $\omega$ .
- 4.2 (2 points) At what frequency  $\omega^*$  there is an extremum of the function  $(|V_{out} / V_{in}|)(\omega)$ ? Is it MIN or MAX?
- 4.3 (3 points) At what frequency  $|V_{out}| = |V_{in}| / \sqrt{2}$  ?

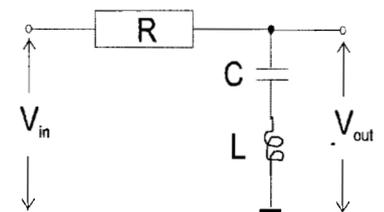


Fig. 4

**Problem 5 (5 points)**

Explain physical methods to measure temperature in the range:

- 5.1 (1 point)  $200 \text{ K} < T < 400 \text{ K}$ ?
- 5.2 (2 points)  $T > 1000 \text{ K}$ ? What are the problems of measuring temperature in this range?
- 5.3 (2 points)  $T < 10 \text{ K}$ ? What are the problems of measuring temperature in this range?