

Toorikkonspekt kursuse “Biofüüsika” füüsikalistest küsimustest

### **3. TULETIS JA INTEGRAAL**

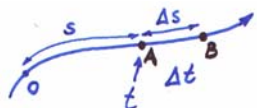
### **DERIVATIVE AND INTEGRAL**

**KÄESOLEVAS FAILIS** sisaldub konspekti toorik aine “Biofüüsika” järgmiste osade jaoks:

*Funktsiooni tuletis ja integraal*

**THE PRESENT FILE** contains provision for the course “Biophysics” corresponding to the following parts of the course:

*Derivative and Integral of a Function*



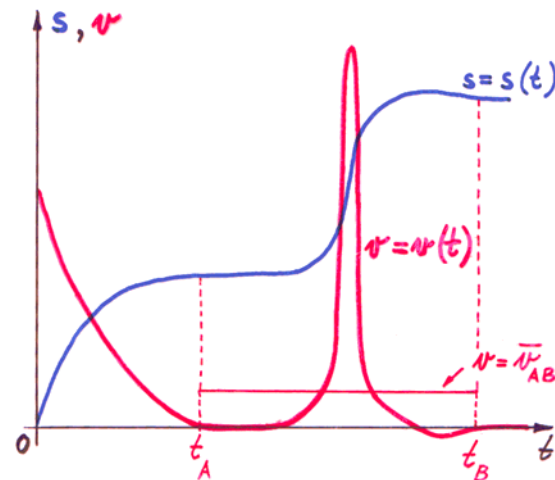
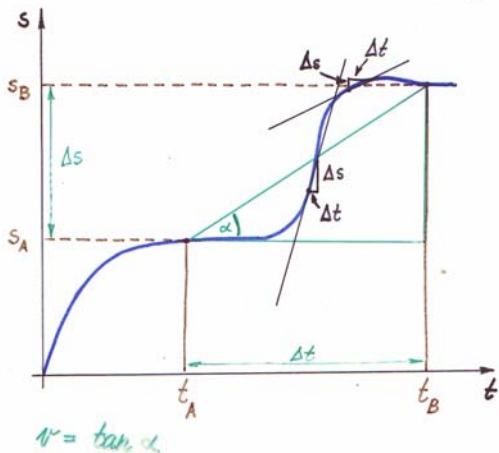
$$s = s(t)$$

$$\bar{v}_{AB} \triangleq \frac{\Delta s}{\Delta t}$$

Keskmine kiirus  
Mean velocity  
Средняя скорость

$$v(t) \triangleq \lim_{\Delta t \rightarrow 0} \frac{\Delta s}{\Delta t}$$

Hetkkiirus  
Current velocity  
Мгновенная скорость



$$y = y(x):$$

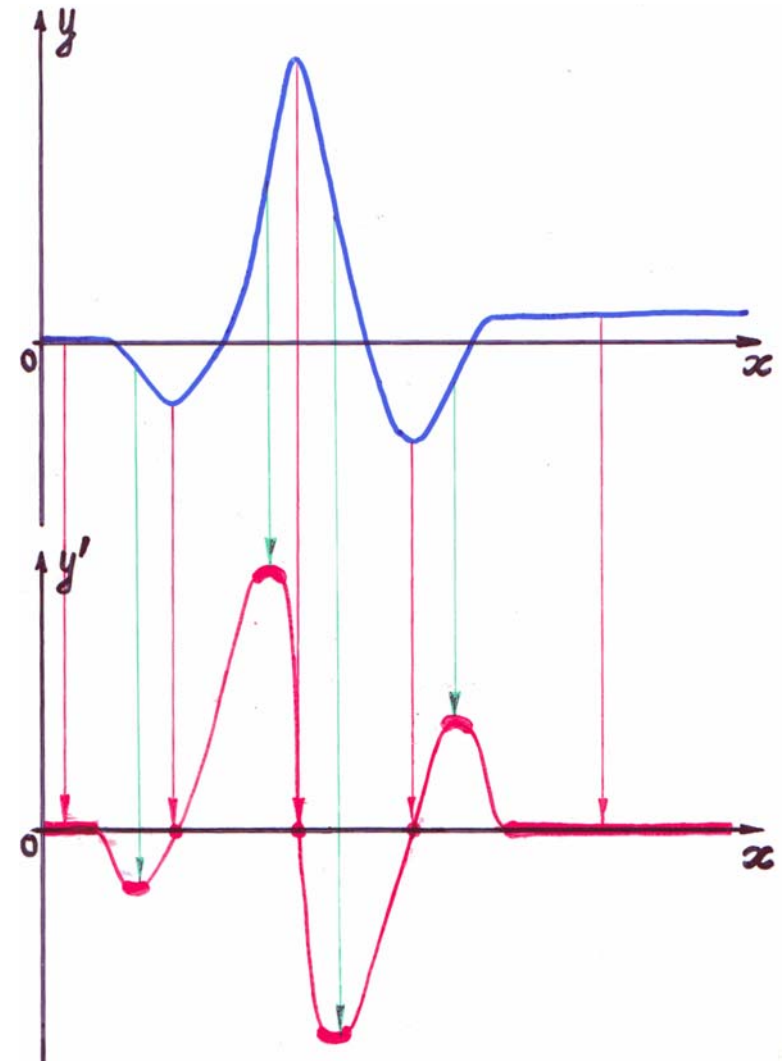
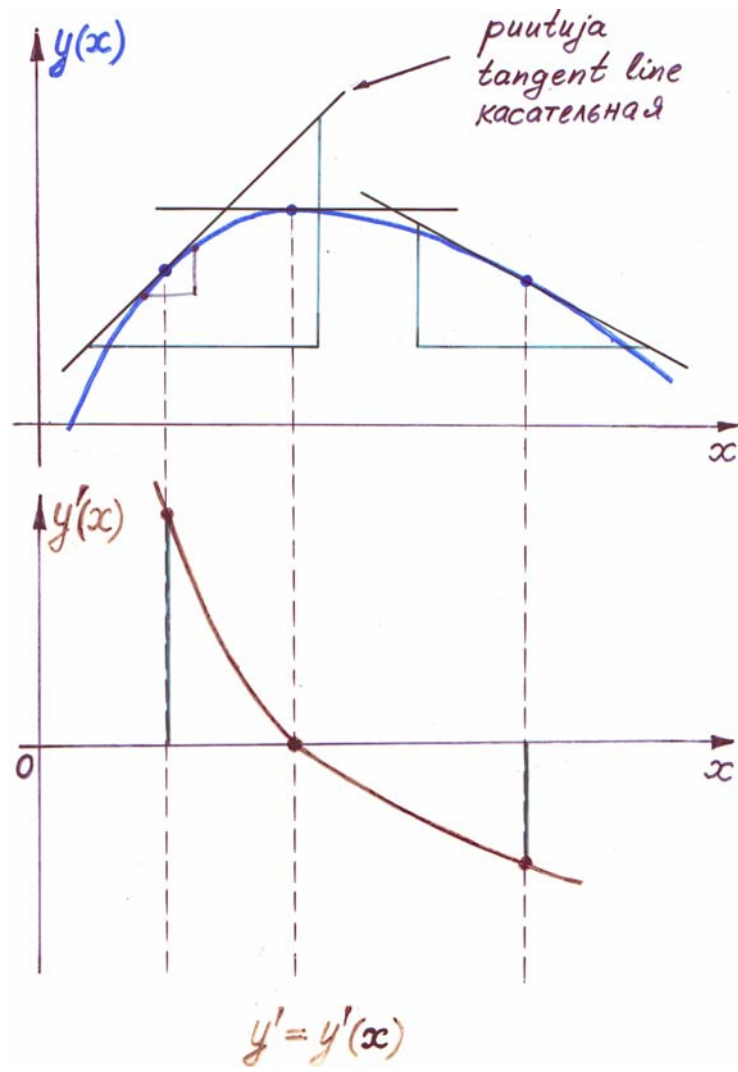
$$y'(x) \triangleq \lim_{\Delta x \rightarrow 0} \frac{\Delta y}{\Delta x}$$

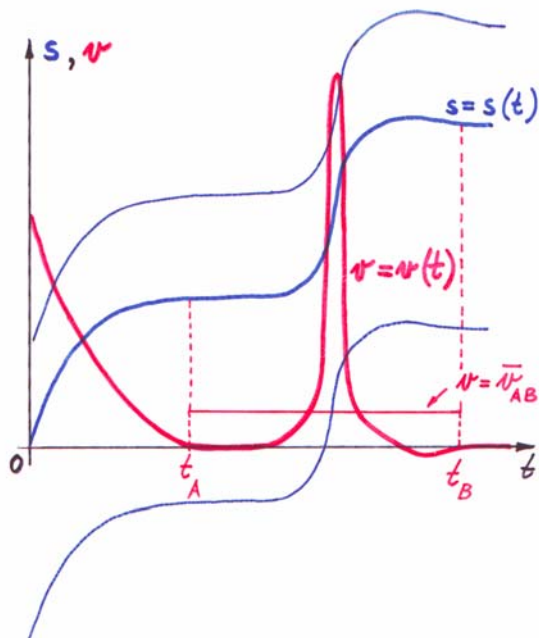
Tuletis (f-n)  
Derivative  
Производная

$$y'(x) \equiv \frac{dy(x)}{dx} \equiv \frac{dy}{dx}$$

NB!  
 $\Delta \leftrightarrow d$

$$v(t) = \frac{ds(t)}{dt}$$



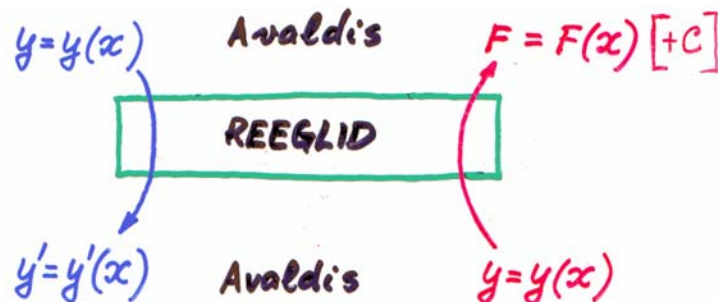


$$F(x): \frac{dF(x)}{dx} = y(x)$$

Algfunktsioon  
Antiderivative  
Первообразная  
Функция

$$F(x) \equiv \int y(x) dx \quad F(x) + C \leftarrow NB!$$

$$s(t) = \int v(t) dt + C$$



Vt.

Look

См. Ремизов, Прилож. § 2-7

$e^x$ :

$$y = e^x \rightarrow \frac{d}{dx}(e^x) = e^x \rightarrow \int e^x dx = e^x + C$$

$$y = e^x$$

$\ln x$ :

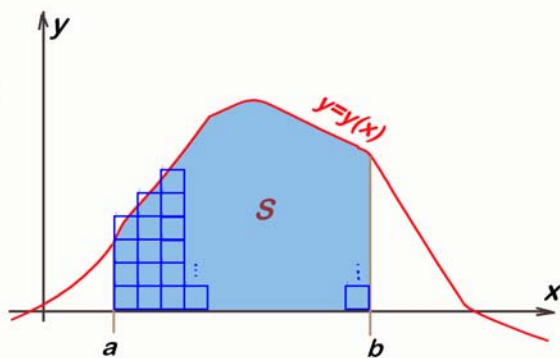
$$y = \ln x \rightarrow \frac{d}{dx}(\ln x) = \frac{1}{x} \rightarrow \int \frac{1}{x} dx = \ln x + C, x > 0$$

$$y = \frac{1}{x}$$

Integraal  
Integral  
Интеграл

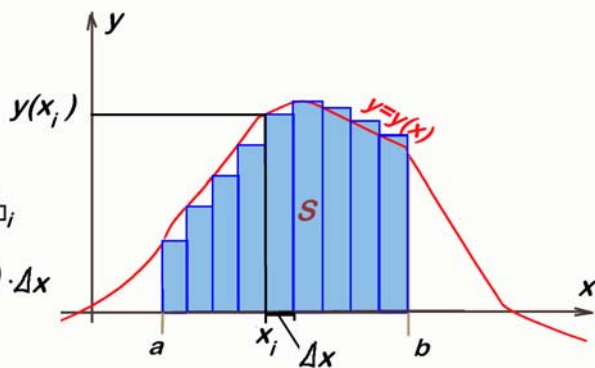
$$S \approx N \cdot S_{\square}$$

$$S_{\square} = \Delta x \cdot \Delta y$$



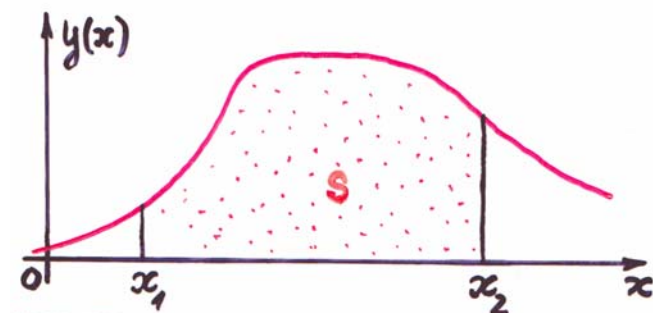
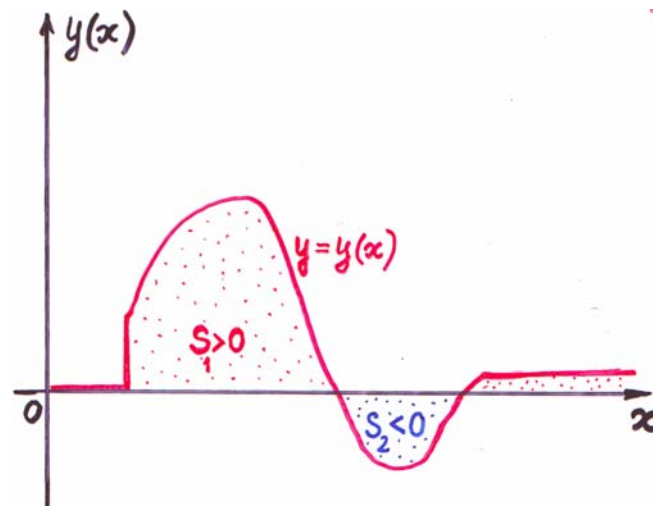
$$S \approx \sum_{i=1}^n S_{\square_i}$$

$$S_{\square_i} = y(x_i) \cdot \Delta x$$



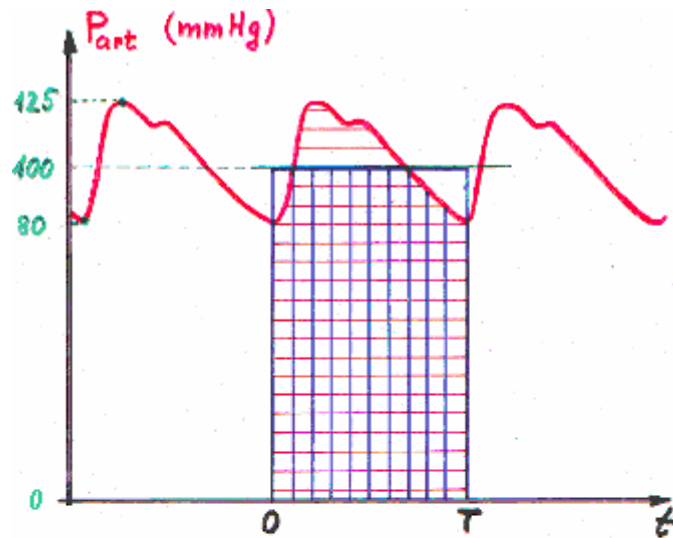
$$S = \lim_{\substack{\Delta x \rightarrow 0 \\ n \rightarrow \infty}} \sum_{i=1}^n y(x_i) \cdot \Delta x \equiv \int_a^b y(x) \cdot dx$$

$S \leftrightarrow \int$



$$S \equiv \int_{x_1}^{x_2} y(x) dx = F(x_2) - F(x_1)$$

Newton,  
Leibnitz



$$\bar{P}_{art} = \frac{S}{T} = \frac{1}{T} \cdot \int_0^T P_{art}(t) dt$$

$y = y(t):$

NB!  
vt.  
look  
on.

s, v

$$\bar{y} = \frac{1}{T} \int_0^T y(t) dt$$

Diferentsiaalvõrrandid  
Differential equations  
Дифференциальные уравнения

Lihtne näide  
Simple example  
Простой пример

$$\frac{dx}{dt} = f(t, x, y, z)$$

Tundmatu funktsioon  
Unknown function  
Неизвестная функция

$$x = x(t)$$

$$x = \tilde{x}_1(t)$$

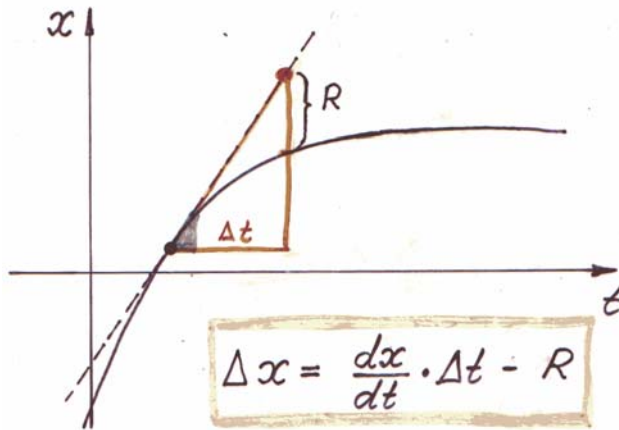
$$x = \tilde{x}(t, c)$$

Algtingimus  
Initial condition  
Начальное условие

$$x(t_0) = A$$

Euleri meetod  
 Euler's method  
 Мерог Эйлера

$$\frac{dx}{dt} = f(t, x, \dots)$$



$$\Delta x = \frac{dx}{dt} \cdot \Delta t - R$$

$$\lim_{\Delta t \rightarrow 0} R = 0$$

$$\Delta x \approx \frac{dx}{dt} \cdot \Delta t$$

