International Conference
The Future of Education

Multidisciplinary strategies in education

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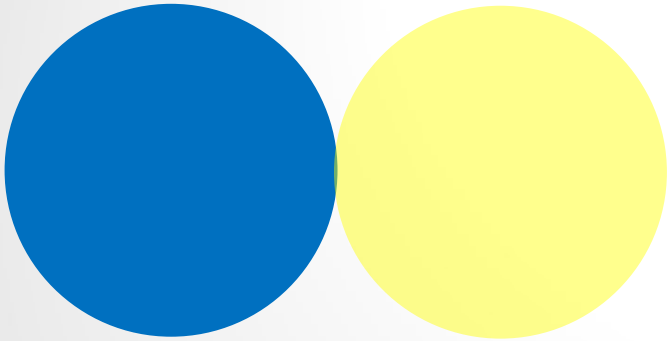
European Training and Research Association for a Cooperation Key to business

Overview

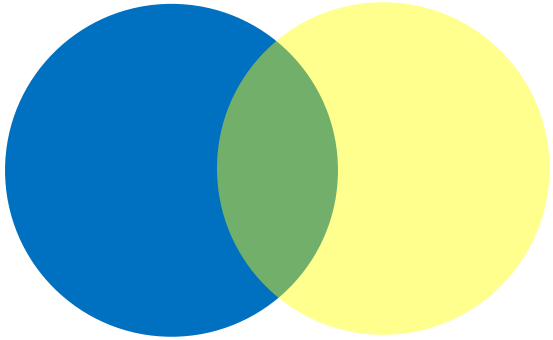
1. Why multidisciplinarity matters? A historical perspective: Mendeleev and Bohr
2. Motivation
3. Multidisciplinary context of nano-scale
4. Electronics, math physiology: points in common
5. Engineering-enhanced math education
6. Crossing the disciplinary borders with Chladni plate

Why

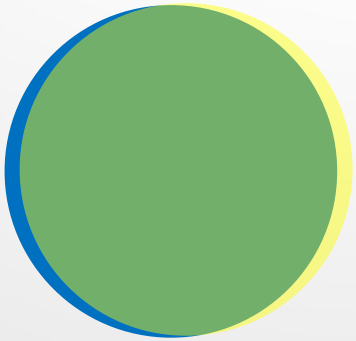
multi–



inter–

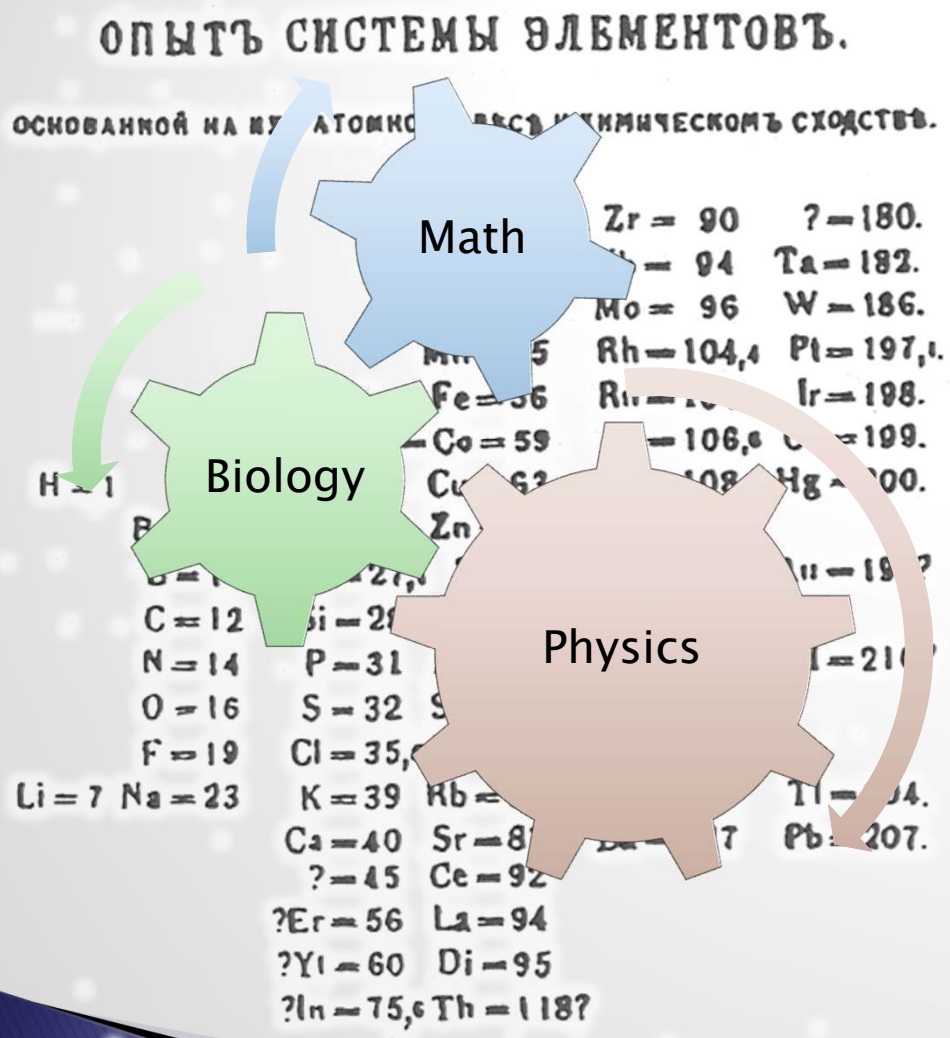


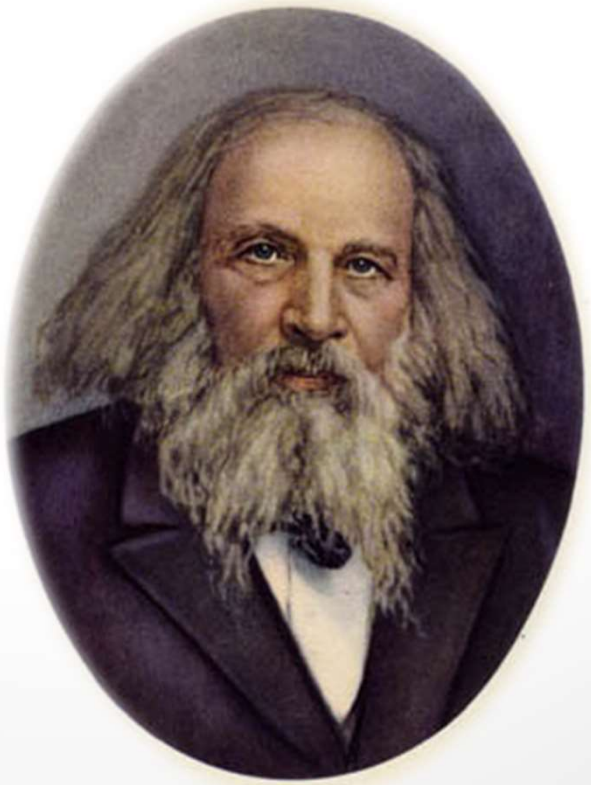
transdisciplinarity



matter?

Historical perspective





D.I. Mendeleev (1834-1907)

Russian chemist, inventor, scientist-encyclopedist

Historical perspective

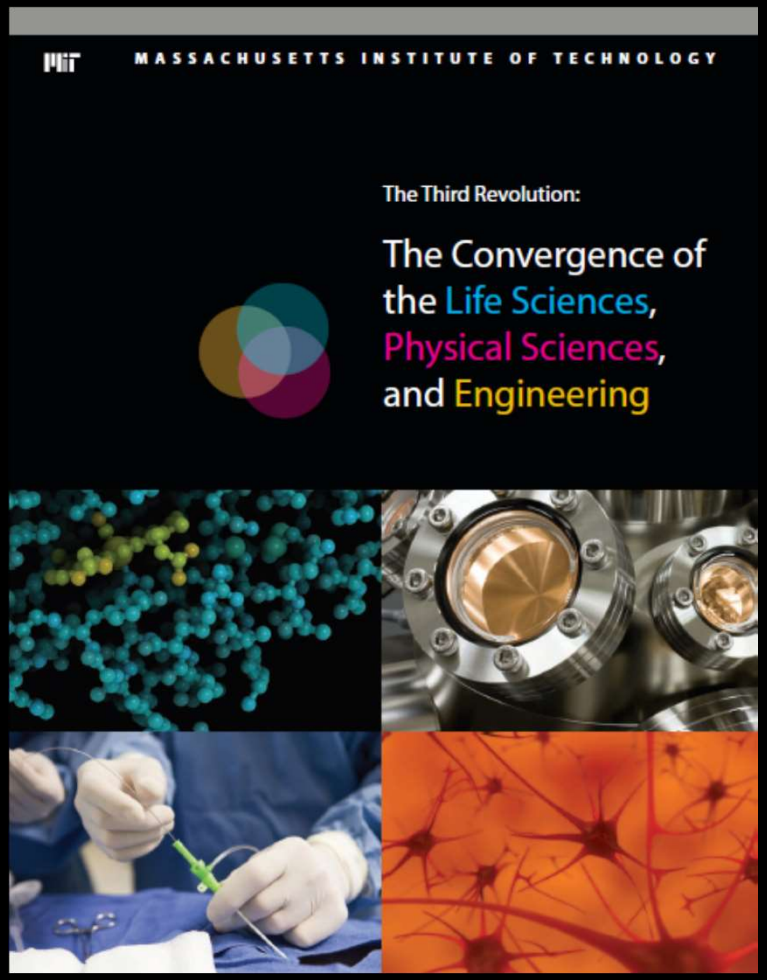
N. H.D. Bohr (1885-1962)

A Danish physicist, philosopher and promoter of scientific research.

Motivation: MIT white paper

"Convergence is not only important for life science research and health care, but is also critical for future revolutionary advances in many fields."

"The successful application of this model will require not simply collaboration between disciplines, but *true disciplinary integration*."



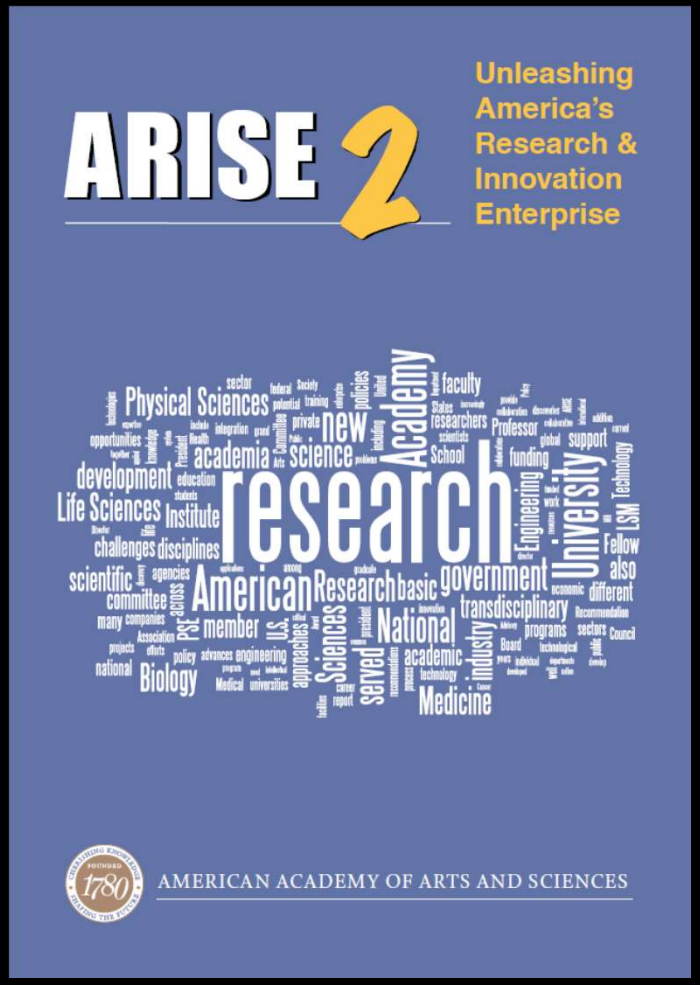
https://www.aplu.org/projects-and-initiatives/research-science-and-technology/hibar/resources/MITwhitepaper.pdf

Motivation: ARISE 2

Advancing Research in Science and Engineering

Goal 1: Move from interdisciplinary to transdisciplinary.

The *transdisciplinary* nature of current scientific and societal challenges—and the powerful new approaches enabled by the combination of traditionally separate disciplines—can be fully addressed only by a rethinking of current academic and government funding structures, as well as the traditional relationships among academia, the private sector, and government.

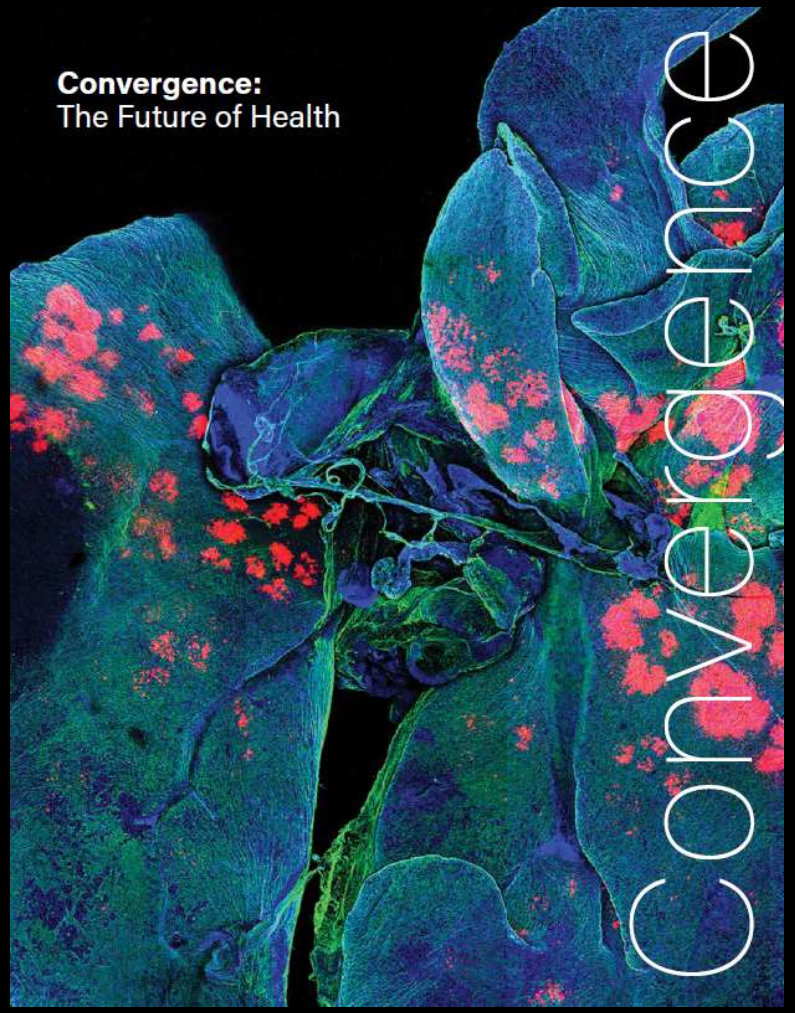


https://www.amacad.org/sites/default/files/publication/downloads/arise2.pdf

Motivation: A strategy for "convergence" research to transform biomedicine

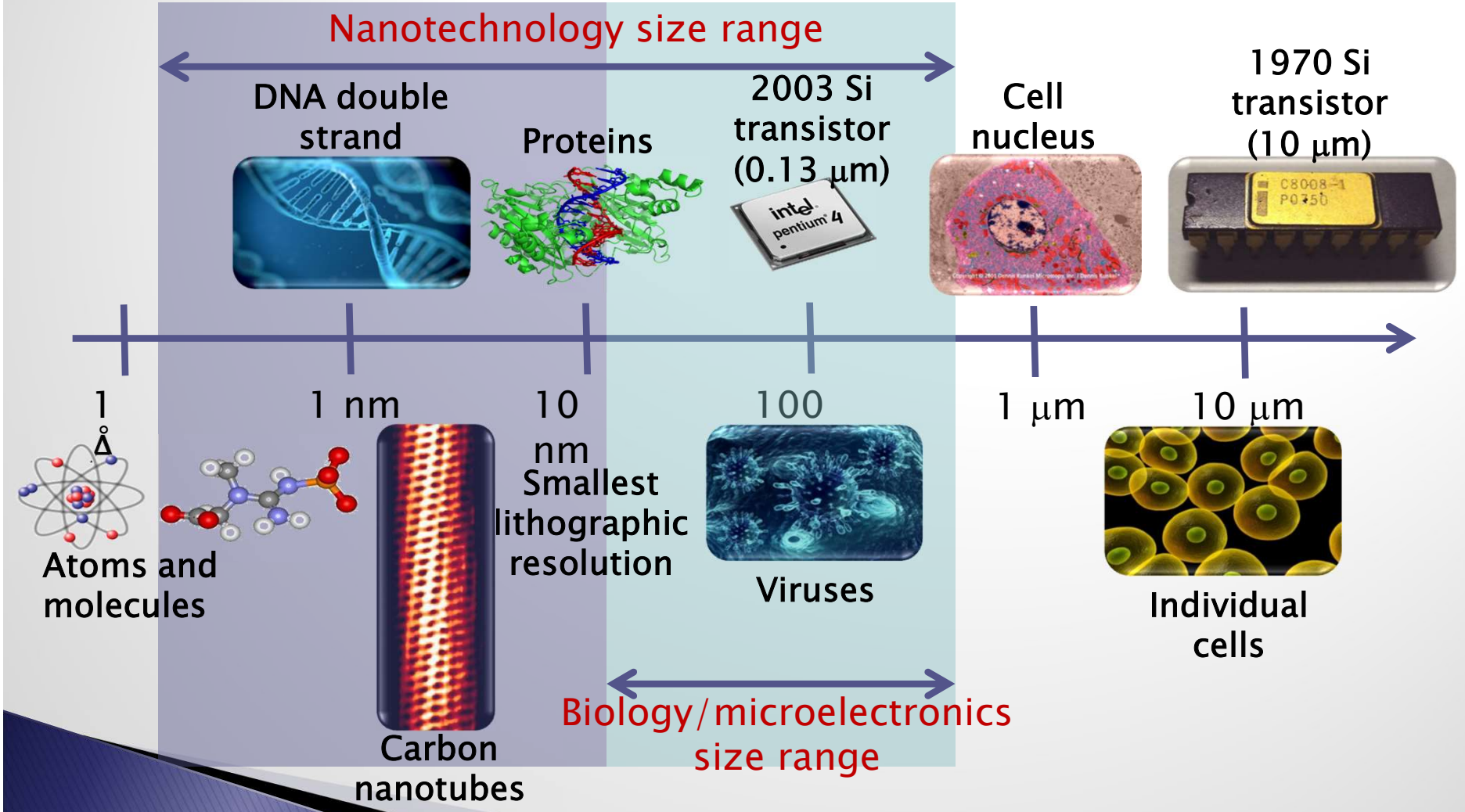
The report outlines three major disease areas — *brain disorders, infectious diseases* and *immunology*, and *cancer* — and promising convergence-based approaches to tackling them.

It also presents case studies of four emerging technology categories: advanced imaging in the body, nanotechnology for drug and therapy delivery, regenerative engineering, and big data and health information technology.

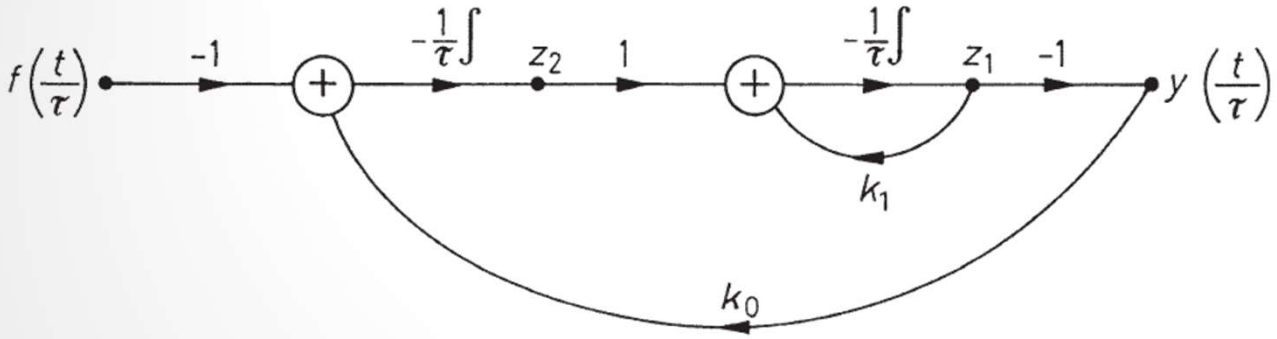


Source: http://www.convergencerevolution.net/2016-report

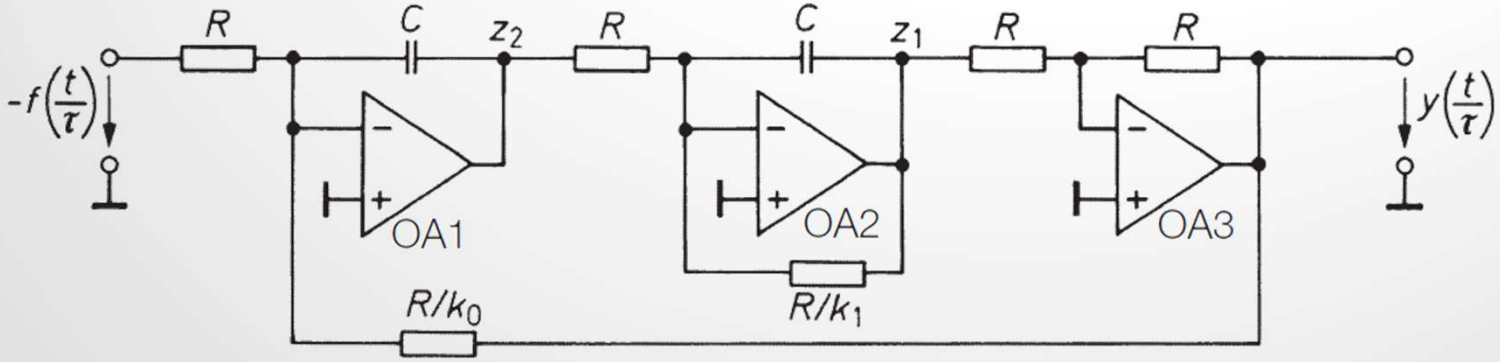
“Nano”: scale consideration



Electronics and math: points in common



Signal flow graph for solving the differential equation $\tau^2 \dddot{y} + k_1 \tau \ddot{y} + k_0 y = f\left(\frac{t}{\tau}\right)$



Practical analog computing circuit

Tietze, U., C. Schenk, and E. Gamm, *Electronic Circuits: Handbook for Design and Application*. 2015: Springer Berlin Heidelberg.

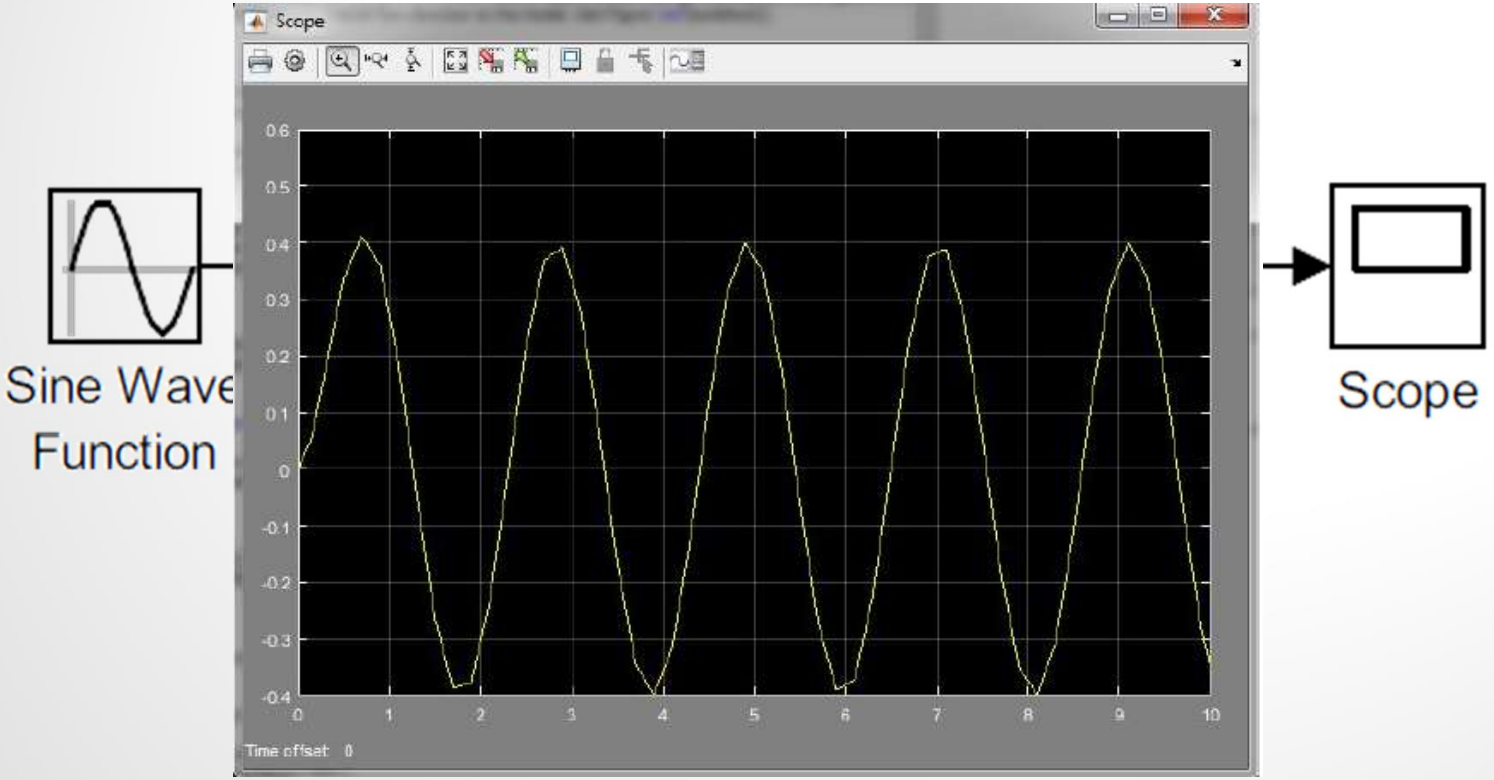
Engineering-enhanced math education

$$LI'' + RI' + \frac{1}{C}I = E_0\omega \cos \omega t \qquad \text{and} \qquad my'' + cy' + ky = F_0 \cos \omega t$$

Electrical System	Mechanical System
Inductance L	Mass m
Resistance R	Damping constant c
Reciprocal $1/C$ of capacitance	Spring modulus k
Derivative $E_0\omega \cos \omega t$ of electromotive force	Driving force $F_0 \cos \omega t$
Current $I(t)$	Displacement $y(t)$

E. Kreyszig, Advanced Engineering Mathematics: Wiley, 1999.

Engineering-enhanced math education



System for solving first order ODE $\frac{dx}{dt} = 2\sin 3t - 4x$ as a Simulink simulation

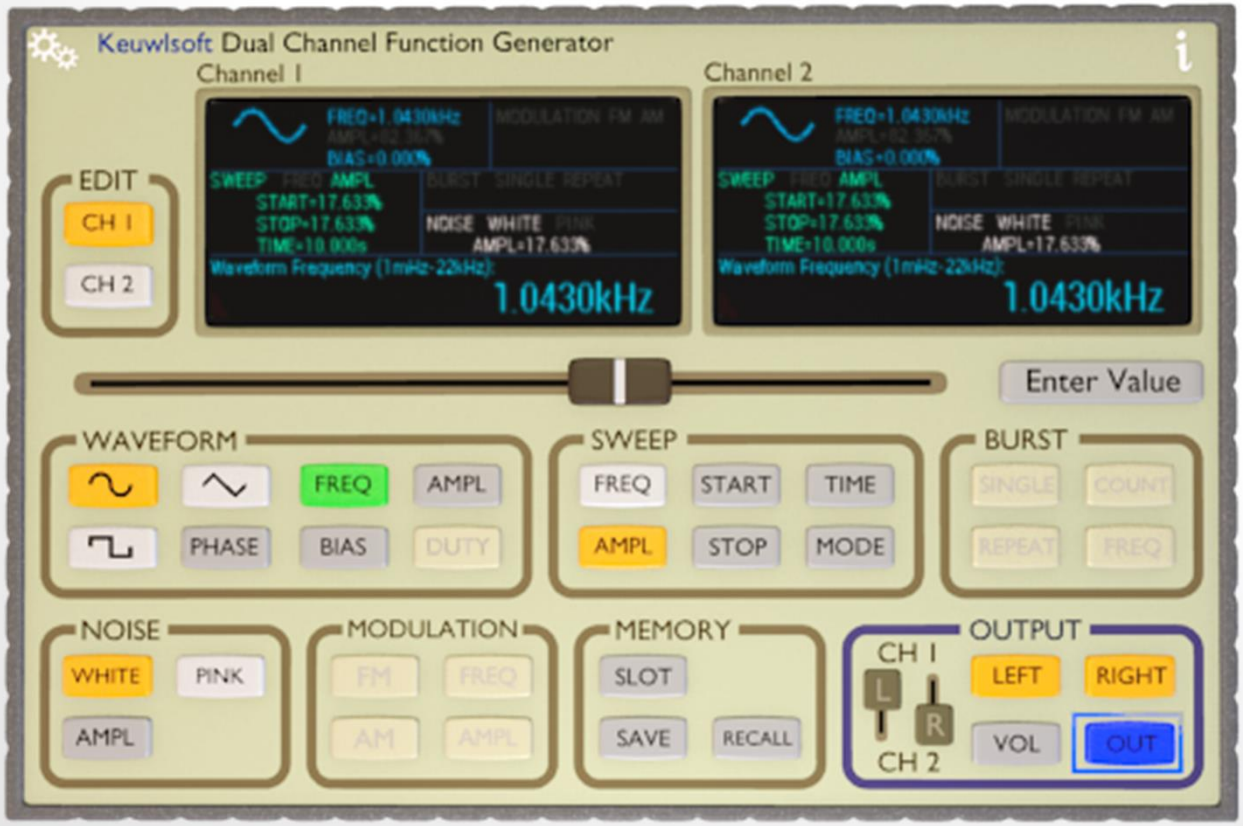
http://people.uncw.edu/hermanr/mat361/simulink/

Electronics and physiology: points in common

Cardiovascular system	Electronic circuit	Equivalence relations
Pressure	Voltage	1V ↔ 10mmHg
Blood Flow	Current	1μA↔100 ml/sec
Resistance	Resistance	1 MΩ ↔1U
Capacitance	Capacitance	1 μF ↔ 100ml/10mmg
Volume	Charge	1μAs ↔ 100 ml

D. G. Tsalikakis, D. I. Fotiadis, and D. Sideris, "Simulation of cardiovascular diseases using electronic circuits," in Computers in Cardiology, 2003, pp. 445–448.

Chladni plate



https://www.youtube.com/watch?v=eb8E9EXLOhU


eu-track
Thank you for your attention!
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