Chapter

Conclusion

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1. To conclude

This textbook aims to acquaint students and those interested in the field of use of technology in medicine with the elementary principles of operation of devices and tools based on the use of various wave phenomena.

In addition to the basic principles, this publication lists and explains some simple applications encountered in the field of biomedicine. However, modern science and technology provide many new sophisticated technical tools that go beyond the scope of this textbook. These are mainly devices of radiology and nuclear medicine. These are also applications of wave processes but in conjunction with sophisticated computational methods that require a more detailed explanation. These are mainly acoustic and optical imaging methods, USG, thermography, tomographic imaging methods, such as CT, MRI, PET, SPECT, and other methodologies, which use radioactive radiation in therapy and diagnostics. The description of these advanced methods will be the content of the prepared book - Technical means of biomedical engineering.

The present textbook uses basic knowledge of mathematics and physics. Special medical applications are going out of the personal experience of authors and current books and journals. Part of the information and most of the documentary images are from publicly available and freely usable Internet sources.

List of used symbols

A	voltage transmission (–)
$\mathbf{A}$	complex voltage transmission (–)
b	oscillation damping coefficient (s^{-1})
B	magnetic induction (T)
c	phase velocity ($m•s^{-1}$), speed of light ($m•s^{-1}$)
$c0$	speed of light in free space ($c0$ = 299,792,458 $m•s^{-1}$ exactly)
C	capacitance (F)
D	electric displacement ($C•m^{-2}$)
e	elementary charge (e = 1,602,177 × 10^{-19} C)
eV	electron-volt unit (1 eV = 1,602,177 × 10^{-19} J)
e_{EM}	electromagnetic field energy density ($J•m^{-3}$)
E	energy (J, eV), e.g., Ep potential, Ek kinetic
E	illuminance (lx)
E	electric field strength ($V•m^{-1}$)
f	frequency (Hz), focal length (m)
fL	Larmor frequency (Hz)
F	force vector (N)
g	gravity acceleration ($m•s^{-2}$)
h	Planck's constant (h = 6,626,070 × 10–34 J•s)
H	loudness level (Ph – phon, dB)

H	magnetic field strength ($A \bullet m^{-1}$)
i	electric current (A)
$\mathbf{I}$	phasor of electric current (A)
I	rms value of electric current (A), luminous intensity (cd)
I	power density of wave (radiation) ($W \bullet m^{-2}$), IdB intensity level (dB)
j	imaginary unit ($j = \sqrt{-1}$)
J	current density ($A \bullet m^{-2}$)
$\mathbf{k}$	complex wave number (m^{-1})
l	length (m)
L	inductance (H), luminance ($cd \bullet m^{-2}$)
L	angular momentum ($N \bullet m \bullet s$)
m	mass (kg)
m	magnetic dipole moment ($N \bullet m \bullet T^{-1}$)
M	torque ($N \bullet m$)
n	refractive index (−)
p	pressure (Pa), power density ($W \bullet m^{-3}$)
p_a	acoustic pressure (Pa)
p	linear momentum ($kg \bullet m \bullet s^{-1}$)
P	power (W), active power (W)
Q	electric charge (C), quality factor (−), reactive power (Var)
r	radius (m), distance (m)
r	wave reflection factor (−)
r	position vector (m)
R	electrical resistance (Ω)
S	apparent power (VA), area (m^2)
$\mathbf{S}$	complex power of the alternating current (VA)
t	time (s)
t	wave transition factor (−)
T	period (s), thermodynamic temperature (K)
u	voltage (V), acoustic displacement (m)
U	rms value of electric voltage (V)
$\mathbf{U}$	voltage phasor (V)
v	velocity vector ($m \bullet s^{-1}$)
V	volume (m^3)
W	work (J)
x_m	amplitude of oscillations (m)
x	coordinate (m), axis designation, displacement in the x- axis direction
y	coordinate (m), axis designation
z	coordinate (m), axis designation
Z	impedance, wave impedance (Ω)
$\mathbf{Z}$	complex impedance (Ω)
α	wavenumber (m^{-1}), angle (rad),
β	wave attenuation coefficient (m^{-1}), angle (rad)
δ	effective wave propagation length (m), wave penetration depth (m)
γ	conductivity ($S \bullet m^{-1}$), gyromagnetic ratio ($s^{-1} \bullet T^{-1}$)
ε	electric permittivity ($F \bullet m^{-1}$), strain (−)
ε_0	electric permittivity of free space ($\varepsilon_0 = 8{,}854{,}187 \times 10^{-12}\ F \bullet m^{-1}$)
ε_r	relative permittivity (−)
λ	wavelength (m)
φ	plane angle (rad), phase shift (rad)

ρ	bulk density ($kg \bullet m^{-3}$), electric charge density ($C \bullet m^{-3}$)
μ	magnetic permeability ($H \bullet m^{-1}$)
μ_0	permeability of free space ($\mu_0 = 4\pi \times 10^{-7}\ H \bullet m^{-1}$)
μ_r	relative permeability (–)
Π	Poynting vector ($W \bullet m^{-2}$)
τ	time constant (s)
τ	mechanical stress in shear (Pa)
σ	mechanical tensile stress (Pa)
Φ	magnetic flux (Wb), luminous flux (lm)
Φ_e	radiation flux density ($W \bullet m^{-2}$)
ω	angular frequency (s^{-1}), angular velocity ($rad \bullet s^{-1}$)
ω_L	Larmor angular frequency (s^{-1})
Ω	angular frequency of forced oscillations (s^{-1}), solid angle (sr)
$\dot{x} = \frac{dx}{dt}$	designation of the first derivative by time
$\ddot{x} = \frac{d^2x}{dt^2}$	designation of the second derivative by time
a, A	designation of a scalar quantity
a, A	designation of a vector quantity
a, A	designation of a complex quantity

Abbreviations

CCD	detection chip (Charge-Coupled Device)
CMOS	detection chip (Complementary Metal Oxide Semiconductor)
CMYK	subtractive colour composition (Cyan-Magenta-Yellow-Black)
CNT	Carbon Nano Tubes
CT	Computed Tomography
EM	electromagnetic
FID	magnetic resonance signal (Free Induction Decay)
IR	Infra-Red
LASER	Light Amplification by Stimulated Emission of Radiation
LCD	Liquid Crystals Display
LED	Light Emitting Diode
MR	Magnetic Resonance
MRI	Magnetic Resonance Imaging
MRS	Magnetic Resonance Spectroscopy
MW	Micro-Waves
PAM	Photo-Acoustic Microscopy
PET	Positron Emission Tomography
RGB	additive colour composition (Red-Green-Blue)
RF, RW	Radiofrequency, Radio-Waves
SPECT	Single Photon Emission Tomography
USG	Ultrasonography
UV	Ultra-Violet
UHF	Ultra-High Frequency
VSW	Very Short Waves
WIFI	wireless connection (Wireless Fidelity)
VL	Visible Light
X	X-rays (Roentgen radiation)
γ	gamma radiation
2D, 3D	two-, three-dimensional

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