

# COMMON KNOWLEDGE DOMAINS FOR PHYSICISTS

SPS PHYSICS STUDENT INNOVATORS (\*AND ALUMNI)



## FOUNDATIONS

### Physics Disciplines

- 01 Mechanics & Nonlinear Dynamics
- 02 Electromagnetism
- 03 Thermal & Statistical Physics
- 04 Fundamental Quantum Phenomena
- 
- 05 Nuclear & Elementary Particle Physics
- 06 Atomic & Molecular Physics
- 07 Optics & Photonics
- 08 Condensed Matter Physics
- 09 Fluid Dynamics
- 10 Acoustics & Ultrasonics
- 11 Plasma Physics
- 12 Astronomy, Astrophysics, Cosmology & Gravitation
- 
- 13 Biophysics & Medical Physics
- 14 Chemical Physics & Physical Chemistry
- 15 Polymer & Soft Matter Physics
- 16 Mesoscopic Physics & Nanoscience
- 17 Complex Systems & Networks
- 18 Physics and Information
- 19 Geophysics, Atmospheric Physics & Ocean Physics
- 20 Environmental Physics
- 21 Physics in Archeology & Anthropology,
- 22 Sociophysics & Econophysics
- 23 Art & Physics
- 24 Physics Education Research

### Math & the Other Sciences

- Mathematics
- Chemistry
- Biology
- Earth Sciences
- Environmental Science
- Geography

### Engineering

- Mechanical Engineering
- Electrical Engineering
- Computer Engineering
- Civil Engineering
- Industrial Engineering
- Architectural Engineering
- Chemical Engineering
- Bioengineering
- Automotive Engineering
- Aerospace Engineering
- Naval Engineering
- Ocean Engineering
- Geotechnical Engineering
- Environmental Engineering

### Art, Humanities, Psychology & Social Science

- Writing & Rhetoric
- Languages & Cultures
- Classics
- Philosophy
- Value and Aesthetics
- Ethics
- 
- Poetry
- Literature
- Creative Writing
- Visual art & Photography
- Architecture and Design
- Sculpture
- Crafts
- Music
- Dance
- Theater & film
- 
- History
- Anthropology & Archeology
- Ethnic & Gender Studies
- Psychology
- Sociology
- Political Science
- Economics

### Education and Human Development

(many fields corresponding to topics of learning and stages of development)

## METHODS & TECHNOLOGIES

### Technical Repertoire

- 01 Design & early prototyping
- 02 Safety & hazardous materials
- 03 Hand tools & handheld power tools
- 
- 04 Materials
- 05 Fabrication
- 06 Chemical methods
- 
- 07 Energy systems
- 08 Measurement & sensors
- 09 Spectroscopic & analytical instrumentation
- 
- 10 Structural systems
- 11 Buildings, labs & work areas
- 12 Geotechnics, hydraulics & landscape design
- 
- 13 Machines & mechanisms
- 14 Actuators
- 15 Vehicles
- 
- 16 Rigging & materials handling
- 17 Rotating, vibrating & chaotic systems
- 18 Sound & ultrasound
- 
- 19 Fluid systems
- 20 Thermal systems
- 21 Vacuum & high pressure
- 
- 22 Electronic test & measurement
- 23 Analog electronics & electronics construction
- 24 Radio frequency & microwave systems
- 
- 25 Digital logic, FPGAs, microprocessors & microcontrollers
- 26 Computer-integrated data acquisition and control

### Analytical Repertoire

#### Mathematical Methods of Physics

- Coordinate systems & trigonometry
- Vector analysis
- Tensors
- Linear algebra
- Group theory
- Complex variables & analysis
- Ordinary differential equations
- Special functions
- Integral transforms
- Fourier analysis
- Orthogonal function expansions

### Computational Repertoire

#### Computational Environments

- Mathematica
- Matlab/Simulink
- CAD including stress computation
- Comsol Multiphysics

#### Numerical Methods

- Root finding
- Linear algebra
  - Matrix inversion
  - Eigenvalues
- Optimization
- Integration
- Ordinary Differential Equations
- Partial Differential Equations
  - Finite Difference
  - Finite Element
  - Spectral
- Stochastic Methods
- Image processing

#### Operating systems

- Linux/Android/MacOS/iOS
- Windows

- 27 Human interfaces
- 28 Control systems
- 29 Mechatronics, robotics & automation
- 
- 30 Computers, clusters & servers
- 31 Memory, data storage and input-output
- 32 High data throughput, neural networks, and artificial intelligence
- 
- 33 Signal processing
- 34 Networks & communication systems
- 35 Geospatial systems & internet of things
- 
- 36 Optics & optical systems
- 37 Lasers & photonics
- 38 Imaging & remote sensing
- 
- 39 Electric fields & plasmas
- 40 Magnetic fields & superconductors
- 41 Charged particle optics & instruments
- 42 Nuclear & elementary particle methods
- 
- 43 Microscopy & micromanipulation
- 44 Thin films, microfabrication & microdevices
- 45 Nanoscale microscopy & measurement
- 46 Nanotechnology & atom manipulation
- 
- 47 Molecular biology methods
- 48 Cell & microbiology methods
- 49 Plant & animal biology methods
- 50 Biomedical devices, instrumentation & imaging
- 
- 51 Field work & outdoor skills
- 52 Extreme environments & space systems

Partial differential equations

- Integral equations
- Calculus of variations
- Differential geometry
- Topology

#### Statistical Methods & Stochastic Modeling

- Discrete probability & combinatorics
- Probability distributions
- Regression analysis
- Stochastic processes
- Stochastic differential equations
- Game theory, agents, annealing, & evolutionary methods

#### Code & Website Development

- Version control
- Github
- Programming languages
  - C/C++
  - Python/Julia
  - Java
- R/IDL/SQL
  - LabVIEW
- Web Development
  - HTML/CSS
  - MySQL
  - Javascript/PHP/Perl/Ruby
  - Django /Rails
  - Drupal/Joomla/WordPress/Squarespace
- Parallel computing CUDA
- Mobile device development

#### Data Science

- Machine learning & artificial intelligence
- Data visualization
- Data assimilation

## IMPACT

### Human Applications

- 01 Energy
- 02 Air & water
- 03 Food
- 04 Ecosystems, weather & environment
- 
- 05 Dwellings & the built environment
- 06 Things for daily living
- 07 Maintenance, recycling & disposal
- 08 Transportation
- 
- 09 Family, friends & community
- 10 Health
- 11 Education
- 12 Safety & security
- 
- 13 Information & communication
- 14 Art, craft, hobbies & entertainment
- 15 Sports & recreation
- 16 Hospitality & personal services
- 
- 17 Materials production
- 18 Manufacturing
- 19 Technical supplies, equipment & services
- 
- 20 Marketing, distribution, sales & rental
- 21 Finance, insurance, & real estate
- 22 Management, legal services & government
- 
- 23 Exploration
- 24 Future humans

∞ Creating knowledge

### Research & Innovation

#### Workflow Tools & Methods

- 01 Finding ideas, needs & opportunities
- 02 Preparatory learning
- 03 Project planning
- 04 Project management
- 05 Theoretical modeling
- 06 Code management
- 07 Apparatus / prototype design & construction
- 08 Protocol development & automation
- 09 Performing & documenting lab/shop/studio work & observations
- 10 Data management, analysis & display
- 11 Assessment and conclusions
- 12 Dissemination
- 13 Planning further iterations, pivots, spin-offs & new directions

### Business & Entrepreneurship Repertoire

- Need finding & customer discovery
- Creativity and innovation
- Intellectual property
- Product definition and pricing
- Market segments and revenue estimation
- Business planning
- Pitches & business communication
- Teamwork & leadership
- Work definition & management
- Marketing
- Creating & managing organizations
- Human resources & supervision
- Finance, accounting & insurance
- Global partners & markets
- Production planning & management
- Supply chain management
- Customer relations
- Business law
- Regulatory compliance
- Business history & biography

### Law and Civics Repertoire

(many fields that are aligned with the areas of human application and general aspects of citizenship & government)

