STUDY PLAN · 2026

Three-Year General Science Curriculum

A BSc-style general science programme: from mathematical foundations to quantum physics, physical chemistry and systems biology, using university courses on Coursera and reference textbooks.

Year 1	Year 2	Year 3
Foundations	Core sciences	Advanced sciences
418 h	433 h	400 h

1,251 h of core coursework

6 semesters

86 courses

13 universities

24 reference textbooks

Data collected from coursera.org on 4 and 5 November 2026 · Textbook availability checked on the same dates

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1. About the curriculum

This curriculum reproduces, for self-study, the structure of a general science bachelor's degree: three years, four disciplines and a steady rise in abstraction. It is designed for an adult with end-of-high-school mathematics who can devote about ten hours a week to study.

THE FOUR DISCIPLINES

- **Mathematics.** algebra, calculus, linear algebra, differential equations, numerical methods, statistics.
- **Physics.** mechanics, electromagnetism, waves and optics, modern and quantum physics, condensed matter, cosmology.
- **Chemistry.** general chemistry, physical chemistry, spectroscopy, statistical thermodynamics, chemical biology, quantum chemistry.
- **Biology.** general biology, ecology and evolution, anatomy and physiology, genomics, systems biology.

THE PRINCIPLES BEHIND THE ORDER

- **Mathematics first.** Algebra and functions (S1), then calculus and linear algebra (S2), and finally differential equations and vector calculus (S3) always come one semester before the physics that uses them.
- **Classical physics before modern physics.** Mechanics (S2), electromagnetism (S3) and waves (S4) come before relativity, quantum mechanics and condensed matter (S5).
- **Chemistry follows physics.** General chemistry (S1, S3), then physical chemistry and spectroscopy (S4), statistical thermodynamics (S5) and finally quantum chemistry (S6), once quantum mechanics is in place.
- **Biology scales up.** Cell and genetics (S1), ecology and evolution (S2), the organism (S4), then genome and systems (S6), with statistics (S4) and programming (S1) as tools.
- **One project per semester.** Each semester ends with a capstone or a project that brings several disciplines together.

LANGUAGES AND TOOLS

Python is the main language (S1, S2, S4, S5, S6). MATLAB or GNU Octave is used in S3 and in systems biology. R appears in precalculus (S1) and genomics (S6). The spectroscopy course uses a virtual laboratory.

2. Overview and workload

YEAR	SEM.	CONTENT	HOURS
Year 1 Foundations **418 h**	**S1**	**Refresher and first languages** Algebra: Elementary to Advanced (25 h) Precalculus through Data and Modelling (31 h) Python for Everybody Specialization (79 h) Introduction to Chemistry: Reactions and Ratios (18 h) Introduction to Chemistry: Structures and Solutions (17 h) Biology Everywhere Specialization (22 h)	192 h
	S2	**Calculus, linear algebra and mechanics** Differential Calculus through Data and Modeling (33 h) Integral Calculus through Data and Modeling (25 h) Linear Algebra from Elementary to Advanced (34 h) Introduction to Mechanics Specialization (81 h) Introduction to Biology: Ecology, Evolution, & Biodiversity (53 h)	226 h
Year 2 Core sciences **433 h**	**S3**	**Mathematical tools, electromagnetism and general chemistry** Mathematics for Engineers (127 h) Introduction to Electricity and Magnetism Specialization (88 h) General Chemistry: Concept Development and Application (22 h)	237 h
	S4	**Statistics, waves, physical chemistry and physiology** Statistics with Python (57 h) Physics of Waves and Optics Specialization (57 h) Introduction to Physical Chemistry (19 h) Introduction to Molecular Spectroscopy (12 h) Human Anatomy & Physiology I Specialization (31 h) Chemical Biology (20 h)	196 h
Year 3 Advanced sciences **400 h**	**S5**	**Quantum physics and matter** Understanding Modern Physics Specialization (29 h) Quantum Mechanics for Engineers (54 h) Electrodynamics (55 h) The Physics of Emergence: Introduction to Condensed Matter (39 h) Statistical Molecular Thermodynamics (21 h)	198 h
	S6	**The universe, quantum chemistry and systems biology** Astronomy and Cosmology: Exploring the Universe (28 h) Density Functional Theory (26 h) Genomic Data Science Specialization (56 h) Systems Biology and Biotechnology Specialization (92 h)	202 h
Core curriculum total			**1,251 h**
Options (optional)			+ 364 h

COURSE HOURS PER SEMESTER



SUGGESTED PACE

Over 40 study weeks a year, the curriculum takes about **10 h per week in year 1**, **11 h in year 2** and **10 h in year 3**. Lengths are Coursera's estimates; allow an extra 20 to 30% for reading.

YEAR 1 · 418 HOURS

Foundations

From school mathematics to integral calculus, programming, and a first look at chemistry, biology and mechanics

S1

YEAR 1 · 192 HOURS · ≈ 10 H PER WEEK OVER 20 WEEKS

Refresher and first languages

> Consolidate algebra and functions, learn to program in Python, and discover general chemistry and biology.

TARGET SKILLS

- Equations, inequalities, functions, polynomials and roots
- Exponentials, logarithms, trigonometry and modelling
- Python programming: variables, loops, functions, files, web, SQL
- Measurement, units, stoichiometry, atomic structure, bonding and solutions
- Introductory cells, energy, genetics, evolution and ecology

END-OF-SEMESTER PROJECT

A chemistry calculator in Python: it reads a periodic table from a CSV file, computes molar masses, balances amounts of substance and plans dilutions.

THINGS TO WATCH

- Start with Algebra: the Duke chemistry courses require solid algebra.
- Precalculus uses R for some exercises; installing R and RStudio is enough.

PROGRAMME

1

SPECIALIZATION · 3 COURSES · 25 H

Algebra: Elementary to Advanced

Johns Hopkins University · Beginner

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Algebra: Elementary to Advanced - Equations & Inequalities	Beginner	10 h	4.8 (654)
2	Algebra: Elementary to Advanced - Functions & Applications	Beginner	6 h	4.8 (198)
3	Algebra: Elementary to Advanced - Polynomials and Roots	Beginner	9 h	4.9 (176)

2

SPECIALIZATION · 3 COURSES · 31 H

Precalculus through Data and Modelling

Johns Hopkins University | Beginner | R

Stated prerequisites: Some high school algebra and function basics

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Precalculus: Relations and Functions	Beginner	12 h	4.7 (231)
2	Precalculus: Periodic Functions	Beginner	9 h	4.7 (110)
3	Precalculus: Mathematical Modeling	Beginner	10 h	4.8 (98)

3

SPECIALIZATION · 5 COURSES · 79 H

Python for Everybody Specialization

University of Michigan | Beginner | Python, SQL, SQLite

Stated prerequisites: No prerequisites; designed as an on-ramp to programming

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Programming for Everybody (Getting Started with Python)	Beginner	17 h	4.8 (233,775)
2	Python Data Structures	Beginner	20 h	4.9 (97,365)
3	Using Python to Access Web Data	Beginner	19 h	4.8 (44,591)
4	Using Databases with Python	Beginner	14 h	4.8 (21,659)
5	Capstone: Retrieving, Processing, and Visualizing Data with Python	Beginner	9 h	4.7 (14,483)

4

COURSE · 1 COURSE · 18 H

Introduction to Chemistry: Reactions and Ratios

Duke University | Beginner | single course

Stated prerequisites: Strong algebra foundation

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Introduction to Chemistry: Reactions and Ratios	Beginner	18 h	4.7 (1,417)

5

COURSE · 1 COURSE · 17 H

Introduction to Chemistry: Structures and Solutions

Duke University | Beginner | single course

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Introduction to Chemistry: Structures and Solutions	Beginner	17 h	4.7 (584)

6

SPECIALIZATION · 4 COURSES · 22 H

Biology Everywhere Specialization

University of Colorado Boulder | Beginner

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Biology Everywhere Foundations	Beginner	5 h	4.5 (249)
2	The Little Stuff: Energy, Cells, and Genetics	Beginner	6 h	4.7 (127)
3	The Big Stuff: Evolution and Ecology	Beginner	4 h	4.6 (48)
4	Specialty Topics: Biology Across Disciplines	Beginner	7 h	4.4 (43)

FURTHER READING

Precalculus 2e

OpenStax (Rice University)

Worked exercises on algebra and functions, alongside the two Johns Hopkins specializations.

Free (web and PDF), CC BY 4.0 licence · openstax.org/details/books/precalculus-2e

Python for Everybody: Exploring Data in Python 3

Charles R. Severance

The specialization's official textbook, one chapter per week.

Free (PDF, HTML, EPUB), CC BY 4.0 licence · www.py4e.com/book

Chemistry 2e

OpenStax (Rice University)

Chapters 1 to 8 for the two Duke courses: measurement, atoms, stoichiometry, bonding.

Free (web and PDF), CC BY 4.0 licence · openstax.org/details/books/chemistry-2e

Biology 2e

OpenStax (Rice University)

Units 1 to 3 (chemistry of life, the cell, genetics) for Biology Everywhere.

Free (web and PDF), CC BY 4.0 licence · openstax.org/details/books/biology-2e

S2

YEAR 1 · 226 HOURS · ≈ 11 H PER WEEK OVER 20 WEEKS

Calculus, linear algebra and mechanics

> Master differential and integral calculus and linear algebra, then apply them to Newtonian mechanics; broaden biology to ecology and evolution.

TARGET SKILLS

- Limits, derivatives, differentiation rules and optimisation
- Integrals, series, integration techniques, introduction to vector calculus
- Linear systems, matrices, determinants, eigenvalues, orthogonality
- Kinematics, forces, energy, momentum, rotation and gravitation
- Ecology, evolution and biodiversity

END-OF-SEMESTER PROJECT

Simulate in Python the trajectory of a projectile with air drag using Euler's method, compare it with the drag-free solution and plot both curves.

THINGS TO WATCH

- Take Differential Calculus before Integral Calculus, then Linear Algebra.
- Introduction to Mechanics belongs in the second half of the semester, once derivatives are mastered.

PROGRAMME

1

SPECIALIZATION · 4 COURSES · 33 H

Differential Calculus through Data and Modeling

Johns Hopkins University | Intermediate | Data Analysis Software

Stated prerequisites: Some familiarity with precalculus, specifically exponential and logarithm functions

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Calculus through Data & Modeling: Precalculus Review	Beginner	8 h	4.8 (124)
2	Calculus through Data & Modeling: Limits & Derivatives	Beginner	10 h	4.7 (212)
3	Calculus through Data & Modeling: Differentiation Rules	Intermediate	8 h	4.8 (124)
4	Calculus through Data & Modeling: Applying Differentiation	Intermediate	7 h	4.7 (63)

2

SPECIALIZATION · 4 COURSES · 25 H

Integral Calculus through Data and Modeling

Johns Hopkins University | Intermediate

Stated prerequisites: Working knowledge of differential calculus

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Calculus through Data & Modelling: Series and Integration	Intermediate	9 h	4.9 (63)
2	Calculus through Data & Modelling: Techniques of Integration	Intermediate	5 h	4.7 (55)
3	Calculus through Data & Modelling: Integration Applications	Intermediate	6 h	4.6 (28)
4	Calculus through Data & Modelling: Vector Calculus	Intermediate	5 h	4.7 (53)

3

SPECIALIZATION · 3 COURSES · 34 H

Linear Algebra from Elementary to Advanced

Johns Hopkins University | Beginner

Stated prerequisites: Basic algebra (no calculus)

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Linear Algebra: Linear Systems and Matrix Equations	Beginner	10 h	4.7 (183)
2	Linear Algebra: Matrix Algebra, Determinants, & Eigenvectors	—	15 h	4.8 (79)
3	Linear Algebra: Orthogonality and Diagonalization	Intermediate	9 h	4.8 (56)

4

SPECIALIZATION · 3 COURSES · 81 H

Introduction to Mechanics Specialization

Rice University | Intermediate

Stated prerequisites: Algebra, geometry, trigonometry; basic calculus helpful

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Physics 101 - Forces and Kinematics	Intermediate	30 h	4.7 (210)
2	Physics 101 - Energy and Momentum	Intermediate	23 h	4.6 (49)
3	Physics 101 - Rotational Motion and Gravitation	Intermediate	28 h	4.8 (104)

5

SPECIALIZATION · 3 COURSES · 53 H

Introduction to Biology: Ecology, Evolution, & Biodiversity

Rice University | Beginner

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Introduction to Biology: Ecology	Beginner	18 h	4.8 (184)
2	Introduction to Biology: Evolution	Beginner	12 h	4.9 (91)
3	Introduction to Biology: Biodiversity	Beginner	23 h	4.8 (84)

FURTHER READING

Calculus, Volume 1 and Volume 2
OpenStax (Rice University)

Volume 1 for differentiation, Volume 2 for integration and series.

Free (web and PDF), CC BY 4.0 licence · openstax.org/details/books/calculus-volume-1

Linear Algebra
Jim Hefferon

A complete textbook with worked exercises, alongside the Johns Hopkins specialization.

Free (PDF), open licence · hefferon.net/linearalgebra

University Physics, Volume 1
OpenStax (Rice University)

University-level mechanics, chapters 1 to 13, alongside Rice.

Free (web and PDF), CC BY 4.0 licence · openstax.org/details/books/university-physics-volume-1

The Feynman Lectures on Physics, Volume I
Richard P. Feynman, Robert B. Leighton, Matthew Sands (Caltech)

The mechanics chapters, to understand the ideas behind the equations.

Free to read online (HTML), no download · www.feynmanlectures.caltech.edu

YEAR 2 · 433 HOURS

Core sciences

Engineering mathematics, electromagnetism, waves, general and physical chemistry, statistics and physiology

S3

YEAR 2 · 237 HOURS · ≈ 12 H PER WEEK OVER 20 WEEKS

Mathematical tools, electromagnetism and general chemistry

> Acquire differential equations, vector calculus and numerical methods, then apply them to electricity and magnetism; deepen general chemistry.

TARGET SKILLS

- Matrix algebra and differential equations
- Vector calculus: gradient, divergence, curl, integral theorems
- Numerical methods and scientific programming in MATLAB
- Electric fields, potential, circuits, magnetism, induction and Maxwell's equations
- Thermochemistry, equilibria, kinetics and bonding models

END-OF-SEMESTER PROJECT

The Mathematics for Engineers capstone: numerical computation of the flow past a cylinder (Kármán vortex street).

THINGS TO WATCH

- Take Vector Calculus for Engineers before Rice's Physics 102 courses on magnetic fields and Maxwell.
- Install MATLAB or GNU Octave.
- General Chemistry (Rice) is not included in Coursera Plus; financial aid is still available.

PROGRAMME

1

SPECIALIZATION · 5 COURSES · 127 H

Mathematics for Engineers

The Hong Kong University of Science and Technology | Beginner | MATLAB

Stated prerequisites: Single variable calculus and some computer programming ability

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Matrix Algebra for Engineers	Beginner	20 h	4.9 (4,726)
2	Differential Equations for Engineers	Beginner	27 h	4.9 (2,251)
3	Vector Calculus for Engineers	Beginner	30 h	4.8 (1,425)
4	Numerical Methods for Engineers	Intermediate	40 h	4.8 (451)
5	Mathematics for Engineers: The Capstone Course	Intermediate	10 h	5.0 (45)

2

SPECIALIZATION · 4 COURSES · 88 H

Introduction to Electricity and Magnetism Specialization

Rice University | Intermediate

Stated prerequisites: Algebra, geometry, trigonometry; basic calculus helpful

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Physics 102 - Electric Charges and Fields	Intermediate	22 h	4.6 (210)
2	Physics 102 - Electric Potential and DC Circuits	Intermediate	22 h	4.8 (35)
3	Physics 102 - Magnetic Fields and Faraday's Law	Intermediate	26 h	4.8 (28)
4	Physics 102 - AC Circuits and Maxwell's Equations	Intermediate	18 h	4.8 (51)

3

COURSE · 1 COURSE · 22 H

General Chemistry: Concept Development and Application

Rice University | single course | not in Coursera Plus

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	General Chemistry: Concept Development and Application	—	22 h	4.7 (1,355)

FURTHER READING

Notes on Diffy Qs: Differential Equations for Engineers

Jiří Lebl

The reference textbook for Differential Equations for Engineers.

Free (PDF and web), CC BY-NC-SA 4.0 and CC BY-SA 4.0 licences · www.jirka.org/diffyqs

Calculus, Volume 3

OpenStax (Rice University)

Multivariable and vector calculus for Vector Calculus for Engineers.

Free (web and PDF), CC BY 4.0 licence · openstax.org/details/books/calculus-volume-3

University Physics, Volume 2

OpenStax (Rice University)

Electricity and magnetism, chapters 5 to 16, alongside Rice.

Free (web and PDF), CC BY 4.0 licence · openstax.org/details/books/university-physics-volume-2

The Feynman Lectures on Physics, Volume II

Richard P. Feynman, Robert B. Leighton, Matthew Sands (Caltech)

Electromagnetism as told by Feynman, for physical intuition.

Free to read online (HTML), no download · www.feynmanlectures.caltech.edu

S4

YEAR 2 · 196 HOURS · ≈ 10 H PER WEEK OVER 20 WEEKS

Statistics, waves, physical chemistry and physiology

> Learn to analyse experimental data, study waves and optics, enter physical chemistry and spectroscopy, and connect biology with chemistry.

TARGET SKILLS

- Descriptive statistics, inference, confidence intervals, regression in Python
- Oscillators, waves, light and materials, geometrical and physical optics
- Gases, thermodynamics and kinetics in physical chemistry
- Molecular spectroscopy: infrared, UV-visible, reading spectra
- Organisation of the human body, tissues, skeleton, muscles, nervous and endocrine systems
- Chemical biology: small molecules, proteins and biochemical assays

END-OF-SEMESTER PROJECT

A statistical study in Python on real laboratory data (spectra or physiological measurements): description, confidence intervals, regression and a two-page report.

THINGS TO WATCH

- Take Introduction to Physical Chemistry before Molecular Spectroscopy, which assumes some background.
- Physics of Waves and Optics requires a year of physics: mechanics (S2) and electromagnetism (S3).

PROGRAMME

1

SPECIALIZATION · 3 COURSES · 57 H

Statistics with Python

University of Michigan · Beginner · Python, Jupyter, Matplotlib, NumPy, pandas, Seaborn, Statsmodels

Stated prerequisites: High school algebra; basic Python recommended

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Understanding and Visualizing Data with Python	Beginner	20 h	4.7 (2,741)
2	Inferential Statistical Analysis with Python	Intermediate	22 h	4.6 (938)
3	Fitting Statistical Models to Data with Python	Intermediate	15 h	4.4 (718)

2

SPECIALIZATION · 3 COURSES · 57 H

Physics of Waves and Optics Specialization

Rice University · Intermediate

Stated prerequisites: A year of introductory physics

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Physics of Oscillators and Waves	Intermediate	20 h	4.8 (20)
2	Physics of Light and Materials	Intermediate	17 h	4.8 (10)
3	Physics of Geometrical and Physical Optics	Intermediate	20 h	—

3

COURSE · 1 COURSE · 19 H

Introduction to Physical Chemistry

University of Manchester · Beginner · single course

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Introduction to Physical Chemistry	Beginner	19 h	4.7 (760)

4

COURSE · 1 COURSE · 12 H

Introduction to Molecular Spectroscopy

University of Manchester | Intermediate | single course

Stated prerequisites: Some related experience required

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Introduction to Molecular Spectroscopy	Intermediate	12 h	4.7 (2,645)

5

SPECIALIZATION · 3 COURSES · 31 H

Human Anatomy & Physiology I Specialization

Rice University | Intermediate

Stated prerequisites: Some medical terminology knowledge (preferred)

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Anatomy & Physiology: Levels of Organization	Intermediate	10 h	4.7 (126)
2	Anatomy & Physiology: Support & Movement	Intermediate	12 h	4.9 (34)
3	Anatomy & Physiology: Regulation, Integration, & Control	Intermediate	9 h	4.8 (36)

6

COURSE · 1 COURSE · 20 H

Chemical Biology

University of Geneva | Intermediate | single course

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Chemical Biology	Intermediate	20 h	4.6 (174)

FURTHER READING

OpenIntro Statistics

David Diez, Mine Çetinkaya-Rundel, Christopher Barr

The most widely used introductory statistics textbook, for Statistics with Python.

Free PDF (optional contribution) · www.openintro.org/book/os

University Physics, Volume 3

OpenStax (Rice University)

Optics and modern physics: chapters 1 to 4 for Waves and Optics, the rest for S5.

Free (web and PDF), CC BY 4.0 licence · openstax.org/details/books/university-physics-volume-3

Anatomy and Physiology 2e

OpenStax (Rice University)

Units 1 to 3 for Human Anatomy & Physiology I.

Free (web and PDF), CC BY 4.0 licence · openstax.org/details/books/anatomy-and-physiology-2e

YEAR 3 · 400 HOURS

Advanced sciences

Modern and quantum physics, electrodynamics, condensed matter, statistical thermodynamics, cosmology, quantum chemistry and systems biology

S5

YEAR 3 · 198 HOURS · ≈ 10 H PER WEEK OVER 20 WEEKS

Quantum physics and matter

> Move from classical to modern physics: relativity, quantum mechanics, advanced electrodynamics, condensed matter and statistical thermodynamics.

TARGET SKILLS

- Introductory special relativity, atoms and quanta
- Schrödinger equation, angular momentum, approximation methods
- Advanced solutions of Maxwell's equations
- Phases of matter, universal theories, modern topics in condensed matter
- Partition functions and the link between molecular properties and thermodynamics

END-OF-SEMESTER PROJECT

Solve the one-dimensional Schrödinger equation numerically in Python (finite well, harmonic oscillator) by finite differences, and compare the energy levels with theory.

THINGS TO WATCH

- Start with Understanding Modern Physics, the gentlest entry point.
- Electrodynamics (KAIST) is rated Advanced: take it after S3 electromagnetism and vector calculus.
- The Physics of Emergence has only 20 reviews; rely on Tong's notes.

PROGRAMME

1

SPECIALIZATION · 3 COURSES · 29 H

Understanding Modern Physics Specialization

The Hong Kong University of Science and Technology · Beginner

Stated prerequisites: Basic classical physics and calculus (highly recommended)

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Understanding Modern Physics I: Relativity and Cosmology	Beginner	11 h	4.6 (174)
2	Understanding Modern Physics II: Quantum Mechanics and Atoms	Beginner	11 h	4.6 (71)
3	Understanding Modern Physics III: Simplicity and Complexity	Beginner	7 h	4.8 (34)

2

SPECIALIZATION · 3 COURSES · 54 H

Quantum Mechanics for Engineers

University of Colorado Boulder | Intermediate

Stated prerequisites: Undergraduate calculus, differential equations and linear algebra

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Foundations of Quantum Mechanics	Intermediate	27 h	4.5 (94)
2	Theory of Angular Momentum	Intermediate	13 h	4.0 (20)
3	Approximation Methods	Intermediate	14 h	4.4 (14)

3

SPECIALIZATION · 4 COURSES · 55 H

Electrodynamics

Korea Advanced Institute of Science and Technology (KAIST) | Intermediate

Stated prerequisites: Basic calculus, high school physics and chemistry

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Electrodynamics: An Introduction	Intermediate	13 h	4.7 (643)
2	Electrodynamics: Analysis of Electric Fields	Advanced	11 h	4.7 (175)
3	Electrodynamics: Electric and Magnetic Fields	Advanced	12 h	4.8 (236)
4	Electrodynamics: In-depth Solutions for Maxwell's Equations	Advanced	19 h	4.8 (129)

4

SPECIALIZATION · 3 COURSES · 39 H

The Physics of Emergence: Introduction to Condensed Matter

University of Colorado Boulder | Beginner

Stated prerequisites: Newtonian mechanics and algebra; linear algebra and basic calculus helpful

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Phases of Matter: Solid, Liquid, Gas and Beyond	Beginner	13 h	4.8 (11)
2	Universal Theories	Beginner	14 h	—
3	Modern Topics in Condensed Matter Physics	Beginner	12 h	4.9 (12)

5

COURSE · 1 COURSE · 21 H

Statistical Molecular Thermodynamics

University of Minnesota | Beginner | single course

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Statistical Molecular Thermodynamics	Beginner	21 h	4.9 (368)

FURTHER READING

Quantum Mechanics

David Tong (University of Cambridge)

Cambridge lecture notes, alongside Quantum Mechanics for Engineers.

Free online lecture notes (PDF) · davidtong.org/teaching/quantum-mechanics

Electromagnetism

David Tong (University of Cambridge)

For the KAIST electrodynamics specialization.

Free online lecture notes (PDF) · davidtong.org/teaching/electromagnetism

Statistical Physics

David Tong (University of Cambridge)

Partition functions, ideal and quantum gases, phase transitions.

Free online lecture notes (PDF) · davidtong.org/teaching/statistical-physics

Solid State Physics

David Tong (University of Cambridge)

For The Physics of Emergence.

Free online lecture notes (PDF) · davidtong.org/teaching/solid-state-physics

The Feynman Lectures on Physics, Volume III

Richard P. Feynman, Robert B. Leighton, Matthew Sands (Caltech)

Quantum mechanics according to Feynman, for intuition.

Free to read online (HTML), no download · www.feynmanlectures.caltech.edu

S6

YEAR 3 · 202 HOURS · ≈ 10 H PER WEEK OVER 20 WEEKS

The universe, quantum chemistry and systems biology

> Apply the tools of physics, chemistry and statistics at three great scales: the universe, the molecule and living systems.

TARGET SKILLS

- Astronomy, galaxies and cosmology
- Density functional theory and electronic structure calculations
- Genomic technologies, Python, command-line tools, Bioconductor and genomic statistics
- Systems biology: experimental methods, networks and dynamical models

END-OF-SEMESTER PROJECT

The final project: the Systems Biology capstone, extended with a dynamical model of a biological network (differential equations) fitted to public data.

THINGS TO WATCH

- Density Functional Theory is rated Advanced and assumes the quantum mechanics of S5.
- Astronomy and Cosmology has just opened and has no reviews yet.
- Systems Biology uses R and MATLAB; Genomic Data Science uses Python, R and Unix.

PROGRAMME

1

SPECIALIZATION · 3 COURSES · 28 H

Astronomy and Cosmology: Exploring the Universe

University of Cambridge · Beginner

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	An Introduction to Astronomy	Beginner	9 h	—
2	Extra-Galactic Astronomy	Intermediate	8 h	—
3	Cosmology	Intermediate	11 h	—

2

COURSE · 1 COURSE · 26 H

Density Functional Theory

École Polytechnique · Advanced · single course

Stated prerequisites: Basic quantum mechanics

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Density Functional Theory	Advanced	26 h	4.8 (257)

3

SPECIALIZATION · 6 COURSES · 56 H

Genomic Data Science Specialization

Johns Hopkins University | Intermediate | Python, R, Bioconductor, Unix

Stated prerequisites: Some statistics, computer science and biology background (helpful, not required)

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Introduction to Genomic Technologies	—	6 h	4.6 (4,901)
2	Python for Genomic Data Science	—	8 h	4.3 (1,830)
3	Algorithms for DNA Sequencing	Beginner	12 h	4.7 (938)
4	Command Line Tools for Genomic Data Science	—	12 h	4.0 (578)
5	Bioconductor for Genomic Data Science	—	9 h	3.8 (388)
6	Statistics for Genomic Data Science	—	9 h	4.2 (383)

4

SPECIALIZATION · 6 COURSES · 92 H

Systems Biology and Biotechnology Specialization

Icahn School of Medicine at Mount Sinai | Intermediate | R, MATLAB

Stated prerequisites: College-level cell and molecular biology, basic statistics and calculus

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Introduction to Systems Biology	—	19 h	4.3 (577)
2	Experimental Methods in Systems Biology	—	18 h	4.5 (317)
3	Network Analysis in Systems Biology	Intermediate	30 h	4.5 (204)
4	Dynamical Modeling Methods for Systems Biology	—	19 h	4.7 (223)
5	Integrated Analysis in Systems Biology	—	4 h	4.6 (87)
6	Systems Biology and Biotechnology Capstone	—	2 h	4.5 (13)

FURTHER READING

Cosmology

David Tong (University of Cambridge)

Cambridge lecture notes for Cambridge's Coursera specialization.

Free online lecture notes (PDF) · davidtong.org/teaching/cosmology

Density Functional Theory: A Practical Introduction, 2nd edition

David S. Sholl, Janice A. Steckel (Wiley)

The standard practical introduction for the École Polytechnique course.

Paid book · www.wiley-vch.de/en/areas-interest/natural-sciences/density-functional-theory-978-1-119-84086-2

Computational Genomics with R

Altuna Akalin

For the Bioconductor and statistics courses of Genomic Data Science.

Free online, CC BY-NC-SA 4.0 licence · compgenomr.github.io/book

An Introduction to Systems Biology: Design Principles of Biological Circuits, 2nd edition

Uri Alon (CRC Press)

The classic of systems biology: network motifs and genetic circuits.

Paid book · lehmanns.de/shop/naturwissenschaften/21192442-9781439837177-an-introduction-to-systems-biology

6. Options

These specializations are not counted in the total. They suit the end of year 3 or after the curriculum, depending on the chosen direction.

The natural extension of Genomic Data Science: bioinformatics algorithms in Python, from DNA to molecular evolution.

SPECIALIZATION · 7 COURSES · 120 H

Bioinformatics Specialization

University of California San Diego | Beginner | Python

Stated prerequisites: Basic high school biology; ability to think technically

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Finding Hidden Messages in DNA (Bioinformatics I)	Beginner	16 h	4.2 (1,646)
2	Genome Sequencing (Bioinformatics II)	Intermediate	17 h	4.6 (327)
3	Comparing Genes, Proteins, and Genomes (Bioinformatics III)	Intermediate	22 h	4.6 (143)
4	Molecular Evolution (Bioinformatics IV)	Intermediate	18 h	4.5 (79)
5	Genomic Data Science and Clustering (Bioinformatics V)	Intermediate	10 h	4.1 (94)
6	Finding Mutations in DNA and Proteins (Bioinformatics VI)	Intermediate	24 h	4.6 (63)
7	Bioinformatics Capstone: Big Data in Biology	Intermediate	13 h	3.7 (29)

A second, more engineering-oriented approach to statistical thermodynamics, after the Minnesota course.

SPECIALIZATION · 5 COURSES · 34 H

Statistical Thermodynamics Specialization

University of Colorado Boulder | Advanced | Mathematical Software

Stated prerequisites: Undergraduate engineering thermodynamics

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Fundamentals of Macroscopic and Microscopic Thermodynamics	Advanced	9 h	4.3 (271)
2	Quantum Mechanics	Advanced	6 h	4.5 (752)
3	Ideal Gases	Advanced	6 h	4.5 (145)
4	Dense Gases, Liquids and Solids	Advanced	5 h	4.5 (117)
5	Non-Equilibrium Applications of Statistical Thermodynamics	Advanced	8 h	4.4 (83)

Synthetic biology: designing, modelling and abstracting genetic circuits. Eligible for CU Boulder academic credit.

SPECIALIZATION · 3 COURSES · 63 H

Engineering Genetic Circuits Specialization

University of Colorado Boulder | Intermediate | Mathematical Software | academic credit

Stated prerequisites: Basic understanding of biology and/or engineering principles (recommended)

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Engineering Genetic Circuits: Design	Beginner	20 h	4.4 (38)
2	Engineering Genetic Circuits: Modeling and Analysis	Intermediate	25 h	—
3	Engineering Genetic Circuits: Abstraction Methods	Intermediate	18 h	—

Materials science: crystal structures, metals, phase diagrams.

SPECIALIZATION · 4 COURSES · 89 H

Materials Science for Technological Application

Arizona State University | Beginner

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Introduction to Materials Science	Beginner	29 h	4.7 (243)
2	Crystal Structures and Properties of Metals	Beginner	24 h	4.8 (41)
3	Shape and Property Control of Metals I & II	Beginner	20 h	4.9 (23)
4	Phase Diagrams I & II	Beginner	16 h	4.6 (31)

The mathematics of machine learning, for those heading towards data science.

SPECIALIZATION · 3 COURSES · 58 H

Mathematics for Machine Learning Specialization

Imperial College London | Beginner | Python, NumPy

Stated prerequisites: High school maths; basic Python helpful for course 3

#	COURSE	LEVEL	LENGTH	RATING (REVIEWS)
1	Mathematics for Machine Learning: Linear Algebra	Beginner	19 h	4.6 (12,618)
2	Mathematics for Machine Learning: Multivariate Calculus	Beginner	18 h	4.7 (5,786)
3	Mathematics for Machine Learning: PCA	Intermediate	21 h	4.0 (3,190)

7. Bibliography

22 of the 24 works can be read free online, under the conditions stated.

1. **OpenStax (Rice University)**. *Precalculus 2e*. Free (web and PDF), CC BY 4.0 licence. openstax.org/details/books/precalculus-2e
2. **Charles R. Severance**. *Python for Everybody: Exploring Data in Python 3*. Free (PDF, HTML, EPUB), CC BY 4.0 licence. www.py4e.com/book
3. **OpenStax (Rice University)**. *Chemistry 2e*. Free (web and PDF), CC BY 4.0 licence. openstax.org/details/books/chemistry-2e
4. **OpenStax (Rice University)**. *Biology 2e*. Free (web and PDF), CC BY 4.0 licence. openstax.org/details/books/biology-2e
5. **OpenStax (Rice University)**. *Calculus, Volume 1 and Volume 2*. Free (web and PDF), CC BY 4.0 licence. openstax.org/details/books/calculus-volume-1
6. **Jim Hefferon**. *Linear Algebra*. Free (PDF), open licence. hefferon.net/linearalgebra
7. **OpenStax (Rice University)**. *University Physics, Volume 1*. Free (web and PDF), CC BY 4.0 licence. openstax.org/details/books/university-physics-volume-1
8. **Richard P. Feynman, Robert B. Leighton, Matthew Sands (Caltech)**. *The Feynman Lectures on Physics, Volume I*. Free to read online (HTML), no download. www.feynmanlectures.caltech.edu
9. **Jiří Lebl**. *Notes on Diffy Qs: Differential Equations for Engineers*. Free (PDF and web), CC BY-NC-SA 4.0 and CC BY-SA 4.0 licences. www.jirka.org/diffyqs
10. **OpenStax (Rice University)**. *Calculus, Volume 3*. Free (web and PDF), CC BY 4.0 licence. openstax.org/details/books/calculus-volume-3
11. **OpenStax (Rice University)**. *University Physics, Volume 2*. Free (web and PDF), CC BY 4.0 licence. openstax.org/details/books/university-physics-volume-2
12. **Richard P. Feynman, Robert B. Leighton, Matthew Sands (Caltech)**. *The Feynman Lectures on Physics, Volume II*. Free to read online (HTML), no download. www.feynmanlectures.caltech.edu
13. **David Diez, Mine Çetinkaya-Rundel, Christopher Barr**. *OpenIntro Statistics*. Free PDF (optional contribution). www.openintro.org/book/os
14. **OpenStax (Rice University)**. *University Physics, Volume 3*. Free (web and PDF), CC BY 4.0 licence. openstax.org/details/books/university-physics-volume-3
15. **OpenStax (Rice University)**. *Anatomy and Physiology 2e*. Free (web and PDF), CC BY 4.0 licence. openstax.org/details/books/anatomy-and-physiology-2e
16. **David Tong (University of Cambridge)**. *Quantum Mechanics*. Free online lecture notes (PDF). davidtong.org/teaching/quantum-mechanics
17. **David Tong (University of Cambridge)**. *Electromagnetism*. Free online lecture notes (PDF). davidtong.org/teaching/electromagnetism
18. **David Tong (University of Cambridge)**. *Statistical Physics*. Free online lecture notes (PDF). davidtong.org/teaching/statistical-physics
19. **David Tong (University of Cambridge)**. *Solid State Physics*. Free online lecture notes (PDF). davidtong.org/teaching/solid-state-physics
20. **Richard P. Feynman, Robert B. Leighton, Matthew Sands (Caltech)**. *The Feynman Lectures on Physics, Volume III*. Free to read online (HTML), no download. www.feynmanlectures.caltech.edu

21. **David Tong (University of Cambridge)**. *Cosmology*. Free online lecture notes (PDF). davidtong.org/teaching/cosmology
22. **David S. Sholl, Janice A. Steckel (Wiley)**. *Density Functional Theory: A Practical Introduction, 2nd edition*. Paid book. www.wiley-vch.de/en/areas-interest/natural-sciences/density-functional-theory-978-1-119-84086-2
23. **Altuna Akalin**. *Computational Genomics with R*. Free online, CC BY-NC-SA 4.0 licence. compgenomr.github.io/book
24. **Uri Alon (CRC Press)**. *An Introduction to Systems Biology: Design Principles of Biological Circuits, 2nd edition*. Paid book. lehmanns.de/shop/naturwissenschaften/21192442-9781439837177-an-introduction-to-systems-biology

8. Method and caveats

- **Data source.** Courses, lengths, levels and ratings come from coursera.org pages collected on 4 and 5 November 2026, and from the “General Science Specializations”, “Data Science Specializations Coursera” and “Computer Science Specializations” files.
- **How hours are counted.** Totals add up the length stated for each course. Coursera's header estimates, which often differ, are not used.
- **Single courses.** The eight chemistry and quantum chemistry courses (Duke, Rice, Manchester, Minnesota, Geneva, École Polytechnique) belong to no specialization; Coursera offers no university specialization in general chemistry.
- **What the curriculum does not replace.** There is no real laboratory work, apart from virtual spectroscopy. Organic chemistry is missing, as Coursera has no English-language university course on it.
- **Catalogue changes.** Coursera regularly changes its courses, lengths and ratings. Check each page before enrolling.
- **Textbooks.** Free availability was checked on the authors' and publishers' websites; two year-3 books are paid.