NEUROVIDYA

PROSPECTUS 2027

Neuroscience without borders



Online Platform offering
Courses, Certificates and Research Training
Bridging Engineering, Medicine, Biology and Psychology

An initiative of Neurogati

neurovidya.neurogati.com

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At a glance

- **Three delivery modes.** Self-paced, blended and instructor-led courses, complemented by mentored research projects.
- **Three credentials.** Course Certificates for individual courses, Professional Certificates for defined programmes of study and a planned Advanced Professional Certificate.
- **One academic calendar.** Six terms govern scheduled offerings; self-paced courses remain available throughout the year.

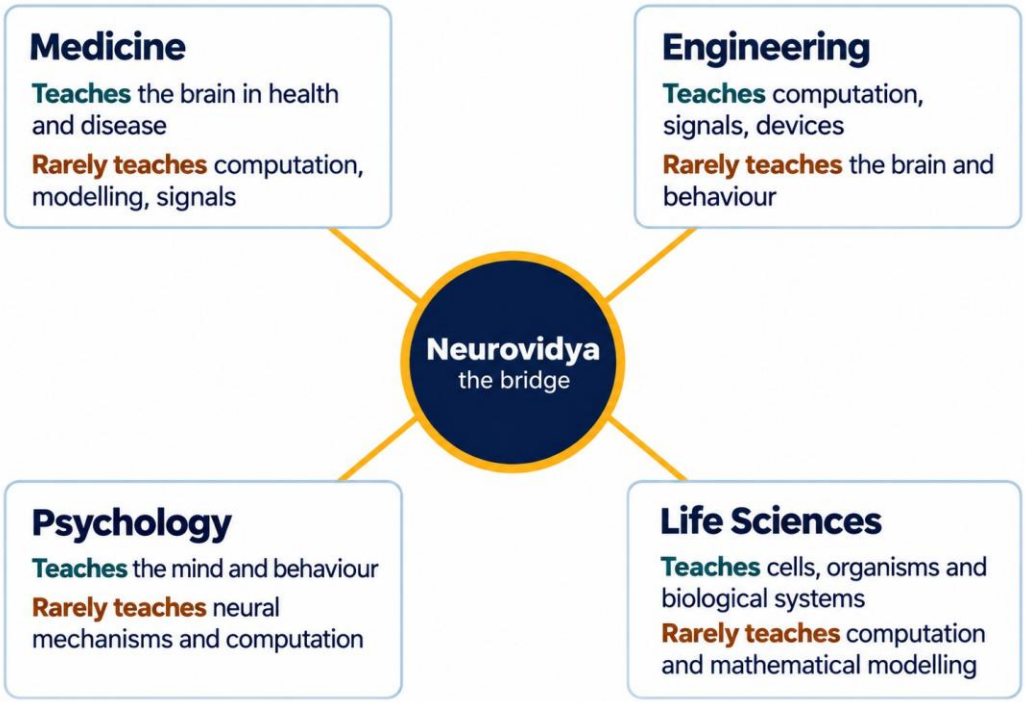
PART 1

Why Neurovidya

An interdisciplinary approach to neuroscience education.

Bridging disciplines in brain science

Many important questions in brain science require knowledge across disciplines. Clinicians encounter mathematical methods in neural decoding studies; engineers developing brain–computer interfaces require an understanding of anatomy; and psychologists using computational models need both. Conventional programmes often provide limited opportunities to develop this combination of knowledge and skills.



Neurovidya addresses these educational needs. As the online school of Neurogati, Chennai, it brings together researchers working across medicine, engineering and psychology. Computational modelling provides a common framework through which learners from these disciplines can study brain function and its applications.

WHO WE SERVE

Learning pathways for diverse backgrounds

Learners enter Neurovidya with different academic backgrounds. Each pathway builds on existing knowledge while developing a shared foundation in neuroscience, Python programming and mathematics.

Learner background	Existing strengths and training needs	Recommended entry courses	Areas of application
Doctors and medical students	Know the brain clinically; need mathematics, data and models	MA050 → PC AI in Clinical Neuroscience; also MA102, CL101, CL102	Clinical data, AI for medicine, computational psychiatry
Engineers and computer scientists	Know computation; need neuroscience	PC Neurotechnology	Neurotechnology, BCIs, NeuroAI
Psychology and cognitive science students	Know behaviour; need brain and computation	PC Computational Psychiatry	Computational psychiatry and cognitive science
Biology and life-science students	Know cells and molecules; need systems and computation	PC Computational Neuroscience	Modelling and neural data analysis
School students (Classes 9–12)	Curious about the brain	SH101 Young Computational Neuroscience Programme	A first research project
Researchers and PhD students	Need specialist methods	200 and 300-level courses, RP projects	Advanced modelling, statistics, signals

What makes Neurovidya different

- **Rigorous assessment.** Every course is assessed in a form suited to it, and that assessment is the basis for certification.
- **Computational practice.** Python notebooks or simulations support the development of practical skills across the curriculum.
- **Accessible learning.** Online delivery, flexible study options and affordable fees support participation across India.
- **Interdisciplinary certificate programmes.** Combines neuroscience, mathematics and programming with engineering, clinical or psychological applications within a single programme.

WHY NOW

Growing needs in neuroscience education and training

Brain disorders are rising with an ageing population, and India's specialist workforce is far below what is needed. At the same time, neurotechnology, brain-inspired AI and data-driven medicine are growing fast. Both trends call for the same people: professionals who understand the brain and can work with data, models and devices.

3.4 billion people	lived with a condition of the nervous system in 2021, 43% of the world. Brain disorders are now the leading cause of ill health and disability. Global Burden of Disease 2021, The Lancet Neurology, 2024
4% → 8.2%	Share of India's total disease burden from non-communicable neurological disorders, 1990 to 2019. It doubled in three decades. India State-Level Disease Burden Initiative, The Lancet Global Health, 2021
0.75 per 100,000	Psychiatrists in India, against a norm of 3. About 9,000 practise; around 36,000 are needed. Most people with a mental disorder receive no care. Parliamentary Standing Committee on Health, 2023; National Mental Health Survey
US$ 33 billion by 2031	Projected global neurotechnology market, growing about 13% a year from US$ 17.8 billion in 2026. Mordor Intelligence, via Research and Markets, 2026

What this means for learners

- **Clinicians** who can read, judge and use computational tools will shape how AI enters neurology and psychiatry.
- **Engineers** who understand the nervous system are needed for neuro-devices, BCIs and rehabilitation technology.
- **Psychologists** trained in computational methods can help close the mental-health gap with scalable, measurable approaches.
- **Biology and life-science students** who can model and analyse neural data can turn cellular and molecular findings into testable hypotheses about whole brain systems.

A WORD FROM THE DIRECTOR

“Neuroscience should be useful to the common person.”



My work in neuroscience began with a background in engineering. I was familiar with mathematical methods but needed to develop a deeper understanding of biology. Over more than 25 years of teaching computational neuroscience, primarily to engineering and biotechnology students, I have also worked with doctors and psychologists whose training offered different strengths. These experiences highlighted the need for educational pathways that connect biological, mathematical and computational perspectives.

Neurovidya seeks to address this need. Our aim is to help clinicians engage with modelling research, engineers understand the clinical context of neural signals, and psychologists examine hypotheses through simulation. Computational modelling connects these perspectives and supports the development of applications in diagnosis, rehabilitation and education.

India carries a substantial burden of brain disorders and faces a shortage of specialists. Expanding access to relevant training therefore requires provision beyond a small number of institutions. Our courses combine online delivery, flexible study options and affordable fees with assessed practical work in programming, data analysis and modelling.

We aim to provide education that meets the needs of researchers, clinicians, industry professionals and students. I invite you to explore the programmes described in this prospectus and identify a pathway suited to your interests and goals.



Prof. V. Srinivasa Chakravarthy
Co-founder & Director, Neurogati

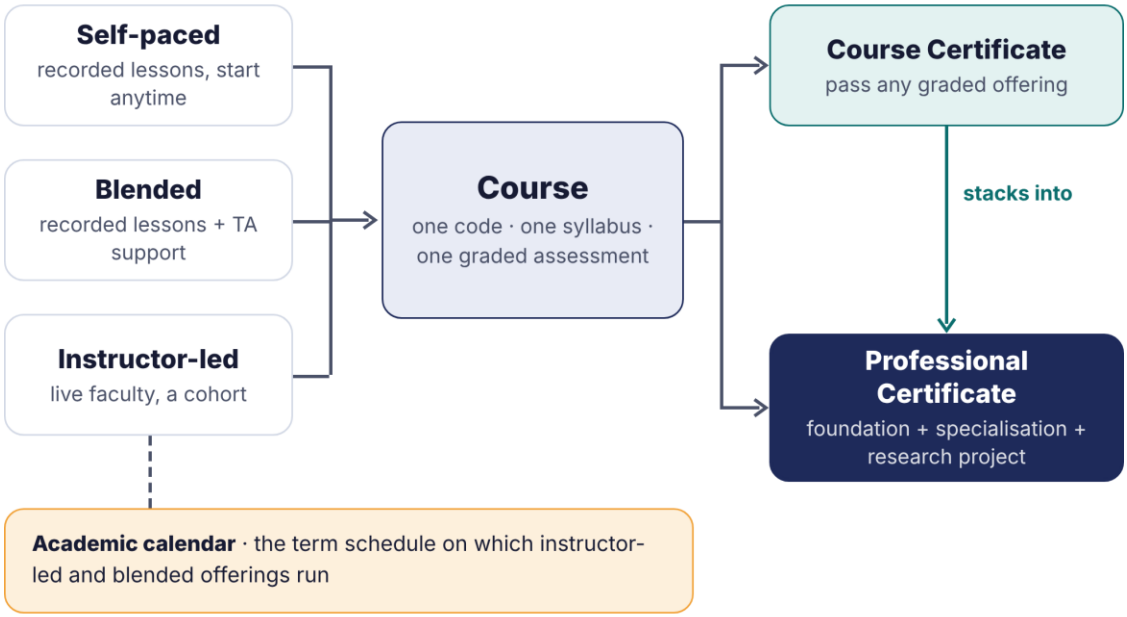
PART 2

How Neurovidya works

Delivery modes, course assessment and pathways to certification.

Course structure and academic credit

Each Neurovidya course has a defined code, syllabus and assessment. Learners may select an available delivery mode according to their needs. Successful completion earns a Course Certificate, which may contribute towards a Professional Certificate where specified.



- **Course.** The unit of credit, e.g. CS101 Python for Neuroscience.
- **Offering.** A scheduled instance of a course in a particular delivery mode, e.g. NS101-2027-SP1.
- **Course Certificate.** Awarded on successful completion of a graded offering; viewing lessons alone does not fulfil the assessment requirements.
- **Professional Certificate.** Earned by completing a defined set of courses, in any mode.

DELIVERY MODES

Delivery modes

Courses may be offered in more than one delivery mode. Learners can select an available format suited to their schedule and learning requirements.

Mode	Learning provision	When	Intended participants
Self-paced	Recorded lectures, auto-graded quizzes and coding exercises, a graded final assessment.	Open all year	Working professionals and independent learners
Instructor-led	Weekly live sessions with faculty, assignments with feedback, a cohort of peers.	Term-based, i.e. runs within a term of the academic calendar	Learners who want structure and interaction
Blended (coming in 2027)	Recorded lessons, scheduled teaching-assistant office hours and structured assessment deadlines.	Term-based or open enrolment with office hours	Learners who want flexibility with support
Mentored research	1, 2 or 3-month projects (RP101–RP301) with weekly mentoring, a written report and presentation.	December, during terms, or over the summer	Learners seeking research experience

ACADEMIC STRUCTURE

Academic Calendar 2027

The academic year comprises six terms for instructor-led and blended offerings. Foundation courses are scheduled in spring, followed by specialisation courses and summer research projects. Fall also introduces proposed Professional Certificates in Computational Psychiatry and AI in Clinical Neuroscience, and repeats the specialisation courses of the spring certificates. Most advanced courses are scheduled in the fall. Self-paced courses remain available throughout the year.

Spring and summer terms

Term	Focus	Courses
SP1 · Jan–Feb	Foundations	NS101 Neuroscience Foundations
		MA101 Mathematics for Neuroscience 01
		NT101 Introduction to Neurotechnology
		MA102 Clinical Study Design and Data Analysis
		MA103 Statistical Foundations for Neuroscience (blended)
		CL101 AI for Medical Analysis 1: Foundations and Applied Machine Learning
		SH101 Young Computational Neuroscience Programme
		RP201 Research Training Project (2 months)
SP2 · Mar–Apr	Specialisations	CN201 Neuron and Network Modelling
		NT201 Introduction to Brain–Computer Interfaces and Neuromodulation
		CN202 Biophysical Neural Modelling
		MA301 Advanced Statistics for Neuroscience
		CL102 AI for Medical Analysis 2: Deep Learning and Research Frontiers
		CL201 Computational Modelling of Stroke Rehabilitation
		SH101 Young Computational Neuroscience Programme
		RP201 Research Training Project (2 months)
SU · May–Jul	Research and Summer School	RP301 Research Training Project (3 months), the capstone of the spring Professional Certificates
		WS101 Neurogati Summer School (June)

Fall and winter terms

Term	Focus	Courses
FA1 · Aug–Sep	Clinical specialisations and advanced courses (proposed)	CS201 Introduction to Reinforcement Learning
		PS201 Introduction to Computational Psychiatry
		CL202 AI for Neurology
		CN301 Dynamical Neuroscience
		CN302 Learning, Decision Making and Motor Control
		CN303 Systems Neuroscience Modelling
		RP201 Research Training Project (2 months)
FA2 · Oct–Nov	Clinical specialisations and advanced courses (proposed)	CN201 Neuron and Network Modelling (repeat run)
		NT201 Introduction to Brain–Computer Interfaces and Neuromodulation (repeat run)
		PS202 Computational Cognitive Science
		CN304 Machine Learning and Deep Learning for Neuroscience
		CN305 Translational Computational Neuroscience
		RP201 Research Training Project (2 months)
		RP301 Research Training Project (3 months), fall capstones (FA2 + WI)
WI · Dec	Schools	WS102 Neurogati Winter School
		RP101 Research Training Project (1 month)
		Fall RP301 capstone presentations

Offering codes identify the academic term, e.g. NS101-2027-SP1. Fall course titles are tentative. Current dates and fees are published at neurovidya.neurogati.com.

CREDENTIALS

Professional Certificates

- **Course Certificate.** Awarded for successful completion of an individual course in any available mode. Admission to advanced courses requires the stated prerequisites or a placement assessment.
- **Professional Certificate.** Awarded on completion of six specified courses covering foundations, specialisation and a research project.
- **Advanced Professional Certificate (planned).** A proposed pathway combining two Professional Certificates with advanced 300-level courses.

Professional Certificates starting in Spring

Programme structure

	PC Computational Neuroscience	PC Neurotechnology
Aim	Model neurons and networks, and analyse neural data.	Understand, develop and evaluate neural recording and stimulation devices.
Foundations	• NS101 Neuroscience Foundations • CS101 Python for Neuroscience • MA101 Mathematics for Neuroscience 01 SP1 or self-paced	• NS101 Neuroscience Foundations • CS101 Python for Neuroscience • MA101 Mathematics for Neuroscience 01 • NT101 Introduction to Neurotechnology SP1 or self-paced
Specialisation	• CN201 Neuron and Network Modelling (SP2) • CN204 Neural Signal Processing (self-paced)	• NT201 Introduction to Brain–Computer Interfaces and Neuromodulation (SP2)
Research project	RP301 Research Training Project (SU, May–July)	RP301 Research Training Project (SU, May–July)
Requirements	Five taught courses and one assessed research project	Five taught courses and one assessed research project
Length	About 7 months, January–July	About 7 months, January–July

NS101, CS101 and MA101 are shared foundation courses across all four Professional Certificates. Previously assessed courses may satisfy the corresponding requirements in another programme. Each certificate requires its own assessed RP301 project in the chosen specialisation.

YOUR ROUTE

Recommended study pathway

The following pathway illustrates the recommended sequence for the Professional Certificate in Computational Neuroscience. Learners may also progress at their own pace, subject to course availability and prerequisites.

1. Before or during SP1: complete CS101 (self-paced) and earn its Course Certificate, which is required for the Professional Certificate.
2. **SP1 · Jan–Feb:** Foundations: NS101 and MA101 live, with a cohort.
3. **SP2 · Mar–Apr:** Specialisation: CN201 Neuron and Network Modelling.
4. **Self-paced, before SU:** Specialisation: CN204 Neural Signal Processing.
5. **SU · May–Jul:** Research project: RP301, a three-month mentored project.
6. **Award:** Professional Certificate in Computational Neuroscience.

The Professional Certificate in Neurotechnology follows the same route, with NT101 added to the SP1 foundations, NT201 as the SP2 specialisation and RP301 in SU.

Professional Certificates starting in Fall

Two additional certificate pathways are proposed for Fall 2027, and the two spring certificates are proposed to run again in the fall. Previously assessed foundation courses carry forward. Learners entering in the fall complete CS101, which is self-paced, and NS101 and MA101 in the SP1 cohort or through their assessed self-paced versions, which are open all year, before the specialisation work that requires them. Faculty and final offering dates will be announced separately.

Programme structure

	PC Computational Psychiatry	PC AI in Clinical Neuroscience
Aim	Use computational models to investigate learning, behaviour and psychiatric symptoms.	Apply and critically evaluate AI methods for neurological data and clinical workflows.
Foundations	• NS101 Neuroscience Foundations • CS101 Python for Neuroscience • MA101 Mathematics for Neuroscience 01 Before August: SP1 or self-paced	• NS101 Neuroscience Foundations • CS101 Python for Neuroscience • MA101 Mathematics for Neuroscience 01 Before August: SP1 or self-paced
Specialisation	• CS201 Introduction to Reinforcement Learning (FA1) • PS201 Introduction to Computational Psychiatry (FA1)	• CL202 AI for Neurology (FA1) • NT210 AI for EEG Bootcamp (self-paced)
Research project	RP301 Research Training Project (FA2 + WI, October–December)	RP301 Research Training Project (FA2 + WI, October–December)
Requirements	Five taught courses and one assessed research project	Five taught courses and one assessed research project
Length	About 5 months, August–December, after the foundations	About 5 months, August–December, after the foundations

Proposed Fall sequence

Before August: complete CS101 (self-paced), and NS101 and MA101 (SP1 cohort or self-paced), or obtain recognition for them. PC Neurotechnology learners also complete NT101.

FA1 · August–September: CS201, PS201 and CL202 run for eight weeks. Complete NT210 AI for EEG Bootcamp through its self-paced offering.

FA2 · October–November: CN201 and NT201 repeat for the spring certificates. RP301 begins with project framing, data preparation and methodological planning; implementation progresses as the relevant teaching is completed.

WI · December: complete RP301 reports, code and presentations.

CL202 introduces machine-learning basics in its first week and applies AI to neurological data and clinical workflows. NT210 develops practical skills in AI for EEG processing. Both courses have their own assessments; the RP301 capstone is a separate project.

Foundation courses are taught once per offering for learners from any pathway. A prior Course Certificate can satisfy a shared taught-course requirement; each new certificate requires a project appropriate to its own specialisation. Project places depend on mentoring capacity.

Frequently asked questions

Can I mix self-paced and live courses?

Yes. Successful completion of a graded offering contributes towards a Professional Certificate when the course is included in its requirements.

Do certificates I have already earned count?

Yes. Previously earned Course Certificates may contribute towards a Professional Certificate when they satisfy its course requirements.

Can I skip a foundation course?

Learners with the required background may enter a higher-level course by demonstrating the stated prerequisites or completing a placement assessment.

What does passing involve?

Assessment may include quizzes, assignments, a project or an examination. Viewing lessons alone does not qualify a learner for certification. All courses require 60% to pass.

Can I take a single course without a certificate programme?

Yes. Individual courses may be taken independently for a Course Certificate. The RP301 capstone is part of the Professional Certificate programmes.

ADDITIONAL LEARNING OPPORTUNITIES

Programmes and Workshops

Alongside credit-bearing courses, Neurovidya offers programmes for young learners, intensive summer and winter schools, and workshops.

Young Computational Neuroscience Programme (SH101)

Three live sessions a week, over eight weeks, introduce school students in Classes 9–12 to neuroscience and computational modelling, culminating in a mentored team project. A cohort runs in each of SP1 and SP2, and each awards a programme certificate.

Neurogati Summer School (June, WS101)

Ten days of live, online lectures and coding on neural modelling, brain dynamics, data and AI, and their applications. More than 30 lectures by faculty from India, Europe and the US, hands-on coding sessions and poster talks. Proceedings are published free.

Neurogati Winter School (December, WS102)

An intensive week of lectures, tutorials and practical sessions each December, with faculty from India and abroad. Learners may combine the school with the one-month Research Training Project (RP101).

Workshops

Short, focused events on fast-moving topics such as AI for EEG and neurotechnology, from one day to a few weeks, announced on the website through the year.

Research Training Projects

- **RP101 · 1 month · WI · December.** A short mentored project, ideal alongside the Winter School. Earns a project certificate.
- **RP201 · 2 months · SP1, SP2, FA1, FA2.** A term-long project on a defined research question, with weekly mentoring.
- **RP301 · 3 months · SU · May–Jul, or FA2 + WI.** The capstone for the Professional Certificate pathways, with a project in the chosen specialisation. Learners carry out a full project, from question to written report and presentation.

Sample Projects

Basic Projects

- Explore a leaky integrate-and-fire neuron under different inputs
- Compare excitation and inhibition in a supplied small circuit
- Analyse stimulus-related firing rates in a public dataset
- Compare EEG responses or spectral power across experimental conditions

Intermediate Projects

- The Moving Enigma Illusion
- Seeing a Face but Not the Person
- Selective Memory Loss in Alzheimer's Disease
- Mood as an Attractor
- Parkinsonian Freezing at a Doorway
- ADHD and Excessive Exploration

Advanced Projects

- Brain rhythms that predict behaviour. Train a classifier-guided deep oscillatory neural network (cDONN) on brain recordings from a perceptual task, so that it reproduces the neural dynamics and predicts the subject's response at the same time. Then find which oscillatory features carry the behavioural information.

BOOKS

Books and supplementary reading

Books by Neurogati authors extend the courses, from popular introductions to research monographs. Several are used as course texts.

Title	Publisher / format	About
Demystifying the Brain	Springer	A plain-language account of how the brain works, for students and general readers.
Computational Neuroscience Models of the Basal Ganglia	Springer	Models of the basal ganglia in health and disease, for advanced learners and researchers.
Whole and Its Parts	Neurovidya · English and Telugu	A 60-page illustrated history of brain discovery.
Purple Suns	Neurovidya	An illustrated exploration of dreams, myth and consciousness as humanity's next frontier.
Neurogati Summer School 2026 Proceedings	Free download	Lectures and papers from the 2026 Summer School.
Mind Meds	Neurovidya	How medicines act on the brain and mind.

Availability, prices and formats are published at neurovidya.neurogati.com.

PART 3

Course syllabi

Course descriptions specify content, intended participants, learning outcomes and contributions towards programme requirements.

Course index

Codes show subject and level: 100 foundation, 200 intermediate, 300 advanced. Subjects: MA mathematics · CS computing · NS neuroscience · NT neurotechnology · CN computational neuroscience · CL clinical · PS psychology and psychiatry · SH schools · WS summer and winter schools · RP research. PC-CN, PC-NT, PC-CP and PC-ACN mark courses that count toward a Professional Certificate.

Code	Course	Term	Counts toward
MA050	Mathematics Primer for Medicos	Start anytime	**Bridge**
NS101	Neuroscience Foundations	SP1 or self-paced	**PC-CN, PC-NT, PC-CP, PC-ACN**
CS101	Python for Neuroscience	Start anytime	**PC-CN, PC-NT, PC-CP, PC-ACN**
MA101	Mathematics for Neuroscience 01	SP1 or self-paced	**PC-CN, PC-NT, PC-CP, PC-ACN**
MA102	Clinical Study Design and Data Analysis	SP1	
MA103	Statistical Foundations for Neuroscience	SP1	
NT101	Introduction to Neurotechnology	SP1 or self-paced	**PC-NT**
CL101	AI for Medical Analysis 1: Foundations and Applied Machine Learning	SP1	
SH101	Young Computational Neuroscience Programme	SP1 and SP2	
NT110	Neurotechnology Bootcamp	Start anytime	
CS201	Introduction to Reinforcement Learning	FA1 · proposed	**PC-CP**
CN201	Neuron and Network Modelling	SP2; FA2 proposed	**PC-CN**
CN202	Biophysical Neural Modelling	SP2	
NT201	Introduction to Brain–Computer Interfaces and Neuromodulation	SP2; FA2 proposed	**PC-NT**
CL102	AI for Medical Analysis 2: Deep Learning and Research Frontiers	SP2	
CL201	Computational Modelling of Stroke Rehabilitation	SP2	
CL202	AI for Neurology	FA1 · proposed	**PC-ACN**
CN204	Neural Signal Processing	Start anytime	**PC-CN**
NT210	AI for EEG Bootcamp	Start anytime	**PC-ACN**
PS201	Introduction to Computational Psychiatry	FA1 · proposed	**PC-CP**
PS202	Computational Cognitive Science	FA2 · proposed	
MA301	Advanced Statistics for Neuroscience	SP2	
CN301	Dynamical Neuroscience	FA1 · proposed	
CN302	Learning, Decision Making and Motor Control	FA1 · proposed	
CN303	Systems Neuroscience Modelling	FA1 · proposed	
CN304	Machine Learning and Deep Learning for Neuroscience	FA2 · proposed	

Code	Course	Term	Counts toward
CN305	Translational Computational Neuroscience	FA2 · proposed	
RP101–301	Research Training Projects	WI, SP–FA, SU	**RP301: all four PCs**

Microcourses

Short self-paced courses that start anytime. Each awards a Course Certificate and does not count toward a Professional Certificate. MA050 is also the bridge course to MA101.

Code	Microcourse	Length	Term
NT105	AI for EEG	5 chapters · 5 lessons	Start anytime
NT100	Neurotechnology Microcourse	7 lessons · about 60 minutes	Start anytime
CN120	Neural Oscillators	4 chapters · 6 lessons	Start anytime
CL110	Human Movement Analysis	3 chapters · 3 lessons	Start anytime
MA050	Mathematics Primer for Medicos	8 chapters · 35 lessons	Start anytime
CS100	Python for Neuroscience	4 chapters · 4 lessons	Start anytime

MA050 100 · BRIDGE · MATHEMATICS

Mathematics Primer for Medicos

The core mathematics for computational neuroscience, biomedical data science and quantitative medicine.

Mode	Self-paced
Term	Start anytime
Duration	8 chapters · 35 lessons
Counts toward	Bridge to MA101
Prerequisites	None. School mathematics.
Who it is for	Medical students, doctors, nurses, pharmacists and allied-health professionals; life-science students preparing for MA101.
Faculty	Prof. V. Srinivasa Chakravarthy
Assessment	Lesson quizzes and a final graded test.

A microcourse on the core mathematics needed for computational neuroscience, biomedical data science and quantitative medicine. It starts with why mathematics matters in biology and medicine, represents biological data with vectors, matrices and functions, and moves on to calculus, dynamical systems, statistics, signal processing and optimisation.

Learning outcomes

On completion you can:

- Build mathematical intuition for biology and medicine: functions, vectors, derivatives, probability and optimisation
- Interpret how biological systems change over time using calculus, differential equations and dynamical systems
- Interpret signals and measurements such as EEG, ECG and neural recordings with signal-processing tools

Modules

1. **The language of mathematics** · Measurement and quantification; variables and mathematical relationships; functions as models; why mathematics is essential in biology and medicine
2. **Representing biological information** · Data types, vectors and tables; organising experimental data
3. **Vectors, matrices and biological systems** · Vectors; matrices and transformations; network matrices
4. **Calculus and dynamical systems** · Derivatives, integrals and differential equations; change over time
5. **Dynamical systems in biology** · State variables; equilibrium and stability; feedback; applications
6. **Statistics and probability** · Understanding variability in biological data; probability and uncertainty; statistical distributions; hypothesis testing; correlation; regression; prediction
7. **Signal processing** · Biological signals and measurements; time-series data; frequency representation; filtering and noise reduction; applications in EEG, ECG and neural signals
8. **Learning and optimisation** · Mathematical foundations of learning; loss functions and error measurement; optimisation principles and gradient descent; foundations of machine learning; neural networks

Labs and projects: Short interactive exercises after every lesson; no programming needed.

Books and readings: Course notes

NS101 100 · FOUNDATION · NEUROSCIENCE

Neuroscience Foundations

How the nervous system is built and how it works, from ion channels to behaviour.

Mode	Instructor-led in SP1, or assessed self-paced
Term	SP1 · Jan–Feb, or self-paced anytime
Duration	Eight weeks · 32 learner hours
Counts toward	PC Computational Neuroscience · Foundation · PC Neurotechnology · Foundation · PC Computational Psychiatry · PC AI in Clinical Neuroscience
Prerequisites	School-level biological literacy; no prior neuroscience course.
Who it is for	Engineering, physics and computer-science learners new to biology; psychology and life-science students; clinicians who want a systems view.
Faculty	Neurovidya faculty
Assessment	Exercises 40% · applied assignment 30% · individual final assessment 30%. 60% to pass.

A common foundation for all four Professional Certificates, covering core neuroscience for engineers, psychologists and clinicians, with emphasis on measurement and modelling.

Learning outcomes

On completion you can:

- Explain neural signalling, from membrane potentials to synaptic integration
- Distinguish the major levels of brain organisation, from cells to systems
- Relate sensory, motor and memory systems to behaviour
- Connect a biological phenomenon to a measurable, testable question

Modules

1. **Organisation and measurement** · Cells, circuits and systems; brain anatomy; what spikes, EEG and imaging measure
2. **Electrical signalling** · Membrane potential, ion gradients, action potentials and refractoriness
3. **Synapses and integration** · Chemical synapses; excitation and inhibition; temporal and spatial summation
4. **Neural coding** · Rate and timing codes; receptive fields; tuning and population representation
5. **Sensory systems** · Visual and somatosensory pathways; stimulus processing and perception
6. **Motor systems** · Cortex, basal ganglia and cerebellum; movement and action selection
7. **Learning and memory** · Plasticity; hippocampal and cortical systems
8. **Scientific integration** · Mechanism vs correlation; hypotheses, experiments and model limits

Labs and projects: Weekly interpretation exercises with supplied plots, no Python needed; an illustrated report on one neural system.

Books and readings: Chakravarthy, Demystifying the Brain (Springer); Purves et al., Neuroscience

CS101 100 · FOUNDATION · COMPUTING

Python for Neuroscience

Python programming for neural data analysis and simulation.

Mode	Self-paced (pre-recorded)
Term	Start anytime
Duration	About 40 learner hours
Counts toward	PC Computational Neuroscience · Foundation · PC Neurotechnology · Foundation · PC Computational Psychiatry · PC AI in Clinical Neuroscience
Prerequisites	School-level algebra and basic computer use; no programming experience. Can be taken before or alongside MA101.
Who it is for	Anyone who needs to analyse or simulate neural data, from biology students to clinicians.
Faculty	Neurovidya faculty
Assessment	Coding exercises 40% · integrated notebook 30% · individual coding assessment 30%. 60% to pass.

Learners begin programming in the first lesson using neuroscience datasets, including spike trains, EEG recordings and behavioural data. The resulting notebooks provide a foundation for subsequent Neurovidya courses.

Learning outcomes

On completion you can:

- Write readable, documented Python notebooks
- Handle arrays and tables with NumPy and pandas
- Visualise neural data with Matplotlib
- Implement a simple numerical simulation with Euler integration
- Build and check a small, reproducible analysis workflow

Modules

1. **Notebook workflow** · Jupyter setup, variables, types, arithmetic and execution order
2. **Program structure** · Conditions, loops, functions and simple debugging
3. **Scientific arrays** · NumPy arrays, indexing, broadcasting and vector operations
4. **Data handling** · pandas tables, CSV loading, metadata and missing values
5. **Visualisation** · Matplotlib traces, distributions, raster plots, labels and units
6. **Numerical modelling** · Time steps, Euler integration and checking known solutions
7. **Analysis and code checks** · Basic summaries, SciPy, random seeds and simple tests
8. **Reproducibility** · File organisation, dependencies, documentation and code explanation

Labs and projects: Weekly coding exercises; a documented notebook that loads data, makes figures and runs a simulation.

Books and readings: VanderPlas, Python Data Science Handbook

MA101 100 · FOUNDATION · MATHEMATICS

Mathematics for Neuroscience 01

The mathematics needed to read quantitative neuroscience, taught through one model neuron.

Mode	Instructor-led in SP1, or assessed self-paced
Term	SP1 · Jan–Feb, or self-paced anytime
Duration	14 modules · 58 lessons · about 8 weeks (24 hours of video, 15 of practice)
Counts toward	PC Computational Neuroscience · Foundation · PC Neurotechnology · Foundation · PC Computational Psychiatry · PC AI in Clinical Neuroscience
Prerequisites	School mathematics (Class 10); no programming. A diagnostic lets Class 12 learners skip modules.
Who it is for	Biology, psychology and medical learners; Class 11–12 students; anyone whose maths stopped at school.
Faculty	Neurovidya faculty
Assessment	Lesson quizzes 20% · module checkpoints 30% · capstone 20% · final assessment 30%. 60% to pass.

Built around a single model neuron, it teaches learners to read the equations of quantitative neuroscience.

Learning outcomes

On completion you can:

- Read the equations in a quantitative neuroscience paper and explain what each term means
- Work fluently with neuroscience units and orders of magnitude
- Sketch and interpret linear, exponential, logarithmic, sigmoid and sinusoidal functions, and explain a time constant
- Represent population activity as a vector and multiply a matrix by a vector
- Interpret a derivative as a rate of change and an integral as an accumulated quantity
- Read an equation of the form dx/dt = f(x), find its steady state and simulate it step by step
- Describe variability with mean, variance and common distributions

Modules

1. **Orientation: why neuroscience speaks mathematics** · Models as explanations; how to read an equation
2. **Numbers, notation and units** · Orders of magnitude, SI prefixes, Σ and Π notation, dimensional analysis
3. **Variables, equations and proportional reasoning** · Rearranging V = IR and Q = CV
4. **Functions and graphs** · f–I curves, slope as gain, threshold-linear functions, inverses
5. **Exponentials, logarithms and power laws** · Time constants, the Nernst equation, log scales, sigmoids
6. **Trigonometry and oscillations** · Sinusoids, phase, EEG rhythms and cosine tuning
7. **Complex numbers (introduction)** · Polar form, Euler's formula and phasors
8. **Vectors** · Population activity vectors, dot products and population-vector decoding
9. **Matrices and linear systems** · Weight matrices, y = Wx, inverses and small linear systems
10. **Rates of change: derivatives** · dV/dt, differentiation rules, sensitivity, partial derivatives
11. **Accumulation: integrals** · Charge as the integral of current, numerical integration, mean rates
12. **Reading differential equations** · Steady states, Euler steps, the leaky integrate-and-fire neuron
13. **Probability and statistics basics** · Mean, variance, distributions and Poisson spike trains
14. **Capstone: reading neuroscience equations** · Four equations annotated, term by term

Labs and projects: A slider notebook in every module, no coding needed; three checkpoints; a capstone.

Books and readings: Neurovidya M0 course notes (61 pp., with exercises and answers); a one-page notation sheet of symbols and units

MA102 100 · FOUNDATION · MATHEMATICS

Clinical Study Design and Data Analysis

An introductory live course for clinicians and health researchers.

Mode	Instructor-led (live)
Term	SP1 · Jan–Feb
Duration	4 live sessions of 90 minutes (6 hours), plus 1–2 hours of worksheet practice
Counts toward	Standalone course
Prerequisites	Basic familiarity with clinical or health research questions. No programming required.
Who it is for	Medical postgraduates, clinicians, physiotherapists, rehabilitation professionals, and psychology and biomedical researchers beginning clinical projects.
Faculty	Dr. R. Vignayanandam Mudappu
Assessment	A quiz after each module; certificate for attending all four sessions and submitting the integrated worksheet.

This course follows a clinical study from research question to interpretation of results, using a running case that compares a rehabilitation intervention with usual care. Learners see how design, outcomes, sample size and statistical choices determine the strength of a study's conclusions.

Learning outcomes

On completion you can:

- Formulate a structured research question and explain the choice of a basic study design
- Select a primary outcome and identify key sources of bias
- State the assumptions needed for sample size planning
- Choose between common introductory analyses, with guidance
- Interpret effect estimates, confidence intervals and basic regression results

Modules

1. **Turning a clinical question into a study** · PICO and follow-up; study designs; populations and comparison groups; bias, randomisation and blinding
2. **Choosing outcomes and planning data collection** · Primary outcomes; measurement quality; data types; sample size; data dictionary, ethics and registration
3. **Choosing an analysis and interpreting group differences** · t-tests, chi-square and ANOVA; confidence intervals and p-values; clinical vs statistical significance; intention to treat
4. **Relationships, prediction and communicating findings** · Correlation and simple regression; association vs causation; writing results; SPIRIT, CONSORT and STROBE

Labs and projects: Worksheets in every session; guided analysis of a teaching dataset in Jamovi; a brief study outline built across the course.

Books and readings: WHO, Guidance for best practices for clinical trials (2024); SPIRIT 2025 and CONSORT 2025; STROBE checklists

MA103 100 · FOUNDATION · MATHEMATICS

Statistical Foundations for Neuroscience

The statistics every neuroscience experiment needs, in four focused modules.

Mode	Blended
Term	SP1 · Jan–Feb
Duration	4 modules · 12 lessons
Counts toward	Standalone course
Prerequisites	None.
Who it is for	Students and researchers who analyse experimental data and want firm statistical footing.
Faculty	Dr. R. Vignayanandam Mudappu
Assessment	A quiz and a worksheet after each module.

A short blended course covering statistical methods frequently used in neuroscience research: descriptive analysis, hypothesis testing, relationships between variables and common analytical errors.

Learning outcomes

On completion you can:

- Apply statistics to spike counts, neuroimaging signals, reaction times and clinical scores
- Move from describing data to inference with hypothesis tests, ANOVA, correlation and regression
- Recognise how a result depends on its assumptions: the distribution, the test and the sample size

Modules

1. **Data, probability and variability** · Descriptive statistics for spike counts and imaging signals; normal, binomial and Poisson distributions; sampling, standard error and within- vs between-subject variability
2. **Distributions and hypothesis testing** · Distributions and z-scores; hypothesis testing, p-values and type I and II errors; confidence intervals
3. **Comparing groups** · Parametric and non-parametric tests (t-tests, Mann–Whitney U, Wilcoxon signed-rank, chi-square); ANOVA and post-hoc tests; power analysis
4. **Relationships and prediction** · Correlation (Pearson, Spearman); regression; correlation versus causation

Labs and projects: Worked examples and case studies from published research; guided tutorials and practice notebooks.

Books and readings: Course handouts

NT101 100 · FOUNDATION · NEUROTECHNOLOGY

Introduction to Neurotechnology

How the nervous system's signals are recorded, imaged and analysed.

Mode	Instructor-led in SP1, or assessed self-paced
Term	SP1 · Jan–Feb, or self-paced anytime
Duration	8 weeks · about 40 learner hours
Counts toward	PC Neurotechnology · Foundation
Prerequisites	None.
Who it is for	Engineers, clinicians, entrepreneurs and students curious about neural recording, brain imaging and neuro-devices.
Faculty	Dr. Bankim Subhash Chander
Assessment	Quizzes and a graded final assessment.

How the nervous system generates electrical and metabolic signals, how these are recorded and imaged with hardware and sensors, and how they are processed for diagnostic and clinical insight.

Learning outcomes

On completion you can:

- Explain how neural electrical activity arises and what can be measured
- Describe the signal chain from electrode to digital data
- Explain how EEG, MEG and EMG are recorded, including evoked potentials and nerve conduction
- Compare structural, functional and molecular imaging methods
- Analyse neural signals in time and frequency and extract biomarkers

Modules

1. **Introduction to neurotechnology** · Recording, imaging, decoding, modulation; open and closed loops
2. **Bioelectricity and measurement principles** · Action potentials; population activity; electrodes
3. **Instrumentation and signal acquisition** · Amplification; sampling and aliasing; signal quality
4. **EEG and MEG** · EEG origins and recording; 10–20 system and montages; MEG; rhythms from delta to gamma
5. **Advanced EEG and evoked potentials** · Sleep and epilepsy; ERPs; artefacts; source localisation
6. **EMG and nerve conduction** · Motor units; surface and needle EMG; nerve conduction studies; F-waves
7. **Structural neuroimaging** · CT; MRI principles and contrasts; diffusion MRI and tractography
8. **Functional and molecular neuroimaging** · fMRI and BOLD; fNIRS; PET; spatial vs temporal resolution
9. **Neural signal processing** · Time and frequency domains; Fourier spectra; filtering; artefact removal
10. **Connectivity and diagnostics** · Time–frequency analysis; multimodal imaging; features and biomarkers

Labs and projects: Explore real EEG and EMG recordings; design brief for a neuro-device.

Books and readings: Course readings

CL101 100 · FOUNDATION · CLINICAL

AI for Medical Analysis 1: Foundations and Applied Machine Learning

Applications, evaluation and limitations of machine learning in clinical data analysis.

Mode	Instructor-led
Term	SP1 · Jan–Feb
Duration	8 weeks over 2 months · about 32 hours
Counts toward	Standalone course
Prerequisites	Basic medical knowledge and computer literacy. No prior AI or programming; basic statistics helpful.
Who it is for	B.Tech and M.Tech students, engineers, MBBS students from second year, interns, residents and practising clinicians.
Faculty	Dr. Chandra Sekhar Vorugunti
Assessment	Weekly quizzes 20% · two assignments 50% · mini-project presentation 30%. 60% to pass.

Clinicians and engineers learn together to frame clinical prediction problems, prepare data, evaluate predictions and build introductory tabular and imaging models. Every concept is anchored to a clinical case, and no prior programming is required.

Learning outcomes

On completion you can:

- Distinguish machine learning, deep learning and generative AI, and match each to medical problems
- Prepare, split and label medical data, and recognise leakage, shortcut learning and biased sampling
- Interpret sensitivity, specificity, predictive values, ROC, calibration and decision curves
- Compare classical models with neural networks and fine-tune an imaging classifier
- Present a clinical mini project with justified thresholds, error analysis and limitations

Modules

1. **AI in medicine and framing a clinical problem** · AI types; decision support; the medical AI lifecycle
2. **Medical data and a first look with Python** · Data types, labels, missing values; pandas in Colab
3. **Classical machine learning for clinical prediction** · Logistic regression, trees; data leakage
4. **Evaluating medical predictions** · Sensitivity, specificity, PPV, NPV; ROC and PR curves; calibration
5. **Stronger tabular models and survival analysis** · Gradient boosting; SHAP; Kaplan–Meier and Cox models
6. **Neural networks from first principles** · MLPs, activations and losses; backpropagation; regularisation
7. **Convolutional neural networks for medical imaging** · DICOM; CNN architectures; transfer learning
8. **Consolidation and mini project** · Clinical AI workflow review; mini project; final assessment

Labs and projects: Weekly Colab notebooks on public data; two assignments and a mini project.

Books and readings: Course readings

SH101 100 · PROGRAMME · SCHOOLS

Young Computational Neuroscience Programme

An introduction to neuroscience research through computational modelling.

Mode	Instructor-led (live programme)
Term	SP1 · Jan–Feb and SP2 · Mar–Apr, one cohort each
Duration	8 weeks · 24 live sessions, three a week
Counts toward	Programme certificate
Prerequisites	Interest in the brain. Classes 9–12.
Who it is for	School students in Classes 9–12.
Faculty	Neurogati researchers
Assessment	Project and presentation.

Eight weeks of live, interactive sessions, three a week, take school students from the foundations of neuroscience, mathematics and Python through three computational approaches (feedforward networks, attractor networks and reinforcement learning) to guided research in teams, ending in a research symposium.

Learning outcomes

On completion you can:

- Explain core ideas about neurons, networks and perception
- Write simple Python simulations
- Build and test a small model of a brain phenomenon
- Present a project to an audience of scientists

Modules

1. **The brain as a scientific mystery**
2. **Mathematics as a language for brain models**
3. **Python for brain modelling**
4. **Neurons and neural signalling**
5. **Feedforward neural networks**
6. **Attractor and recurrent neural networks**
7. **Reinforcement learning**
8. **The research question and model design** · Six teams, two per approach, each take on one research mystery
9. **Building the baseline model**
10. **Running computational experiments**
11. **Analysis and neuroscientific experiments**
12. **Research communication and symposium**

Labs and projects: A mentored research project in small teams.

Books and readings: Chakravarthy, Demystifying the Brain (Springer)

NT110 100 · FOUNDATION · NEUROTECHNOLOGY

Neurotechnology Bootcamp

A ten-module survey of neurotechnology, from the bioelectric origin of neural signals to ethics and careers.

Mode	Self-paced
Term	Start anytime
Duration	10 chapters · 10 lessons
Counts toward	Standalone course
Prerequisites	None.
Who it is for	Students, engineers, clinicians and founders exploring neurotechnology.
Faculty	Prof. V. Srinivasa Chakravarthy
Assessment	Chapter quizzes and a final test.

A systematic, self-paced survey of neurotechnology as the discipline that measures, interprets and influences nervous-system activity: recording, EEG and EMG, neuroimaging, signal processing and machine learning, brain–computer interfaces, neuromodulation, rehabilitation and the future of the field.

Learning outcomes

On completion you can:

- Explain the electrical basis of neural activity, from resting to action potentials
- Work with EEG, EMG, evoked potentials and imaging (CT, MRI, fMRI, PET) and their trade-offs
- Apply signal processing and machine learning to extract biomarkers
- Explain brain–computer interfaces and open- and closed-loop neuromodulation
- Connect these methods to rehabilitation, wearables, ethics and careers

Modules

1. **Foundations of neurotechnology**
2. **Bioelectricity, electrodes and neural recording**
3. **EEG and evoked potentials**
4. **EMG, nerve conduction and peripheral neurotechnology**
5. **Neuroimaging**
6. **Neural signal processing, biomarkers and AI**
7. **Brain–computer interfaces and neuroprosthetics**
8. **Neuromodulation**
9. **Neurorehabilitation, wearables and digital biomarkers**
10. **Future neurotechnology, ethics and careers**

Labs and projects: Short exercises and case studies.

Books and readings: Course notes

CS201 200 · INTERMEDIATE · COMPUTING

Introduction to Reinforcement Learning

From animal learning to mathematical models and Python agents.

Mode	Instructor-led or blended · proposed
Term	FA1 · August–September 2027 · proposed
Duration	8 weeks · 90-minute lecture and 90-minute lab weekly; approximately 24 further hours of study
Counts toward	PC Computational Psychiatry · Specialisation; also available independently
Prerequisites	Basic Python (CS101 or equivalent), school algebra, graphs and elementary probability. MA101 helpful; no prior RL or animal research required.
Who it is for	Neuroscience, psychology, medicine, engineering and computer-science learners new to reinforcement learning.
Faculty	Neurovidya faculty · to be confirmed
Assessment	Quizzes 20% · coding assignments 40% · mini project and explanation 40%. 60% to pass.

Animal learning motivates each mathematical idea, followed by a Python experiment. Learners implement tabular algorithms in NumPy and test them over repeated runs.

Learning outcomes

On completion you can:

- Define states, actions, rewards, policies, returns and value; distinguish reward from expected future reward
- Explain prediction-error learning and derive simple Bellman and temporal-difference updates
- Implement bandits, value iteration, TD learning, SARSA and Q-learning, and test their parameters
- Relate computational predictions to conditioning, instrumental learning and selected dopamine findings without equating every biological signal with a single RL quantity

Modules and Python laboratories

1. **Trial and error** · Thorndike, Skinner, reinforcement and punishment; the agent–environment loop. Lab: simulate rewarded action acquisition.
2. **Conditioning** · Pavlov, acquisition, extinction and blocking; Rescorla–Wagner prediction error. Lab: simulate cue–reward learning and blocking.
3. **Bandits** · Expected reward, sample means, epsilon-greedy and softmax exploration. Lab: compare choices as reward probabilities change.
4. **Sequential decisions** · States, transitions, policies, discounted return and values in a Markov decision process. Lab: maze choice with delayed reward.
5. **Bellman equations** · Policy evaluation, improvement and value iteration. Lab: compute maze values and display the resulting policy.
6. **Learning from experience** · Monte Carlo, TD(0), bootstrapping and learning rate; dopamine prediction-error motivation. Lab: cue–delay TD learning.
7. **Action learning** · SARSA versus Q-learning; on-policy and off-policy learning. Lab: compare exploration and risky routes across repeated runs.
8. **From algorithm to behaviour** · Actor–critic intuition, reversal learning and parameter effects. Lab: project presentation and model limitations.

Labs and projects: Weekly Python labs; a mini project on blocking, reversal learning or maze choice.

Books and readings: Sutton & Barto, Reinforcement Learning (2018); Schultz, Dayan & Montague (1997); course notes

CN201 200 · INTERMEDIATE · COMPUTATIONAL NEUROSCIENCE

Neuron and Network Modelling

Build neurons and networks in code, from a single spike to collective dynamics.

Mode	Instructor-led
Term	SP2 · Mar–Apr; FA2 · Oct–Nov repeat proposed
Duration	Eight weeks · 48 learner hours
Counts toward	PC Computational Neuroscience · Specialisation
Prerequisites	NS101, CS101 and MA101, or equivalent preparation.
Who it is for	Learners who have completed the foundations and want to model neural systems.
Faculty	Neurovidya faculty
Assessment	Simulation exercises 40% · model comparison 30% · individual assessment 30%. 60% to pass.

The core modelling course of the Computational Neuroscience certificate. Learners implement each model themselves and connect its behaviour to experimental data.

Learning outcomes

On completion you can:

- Simulate passive membranes and leaky integrate-and-fire neurons
- Explore a conductance-based (Hodgkin–Huxley) model
- Model synaptic interactions and small excitatory–inhibitory networks
- Compare network behaviour across parameters: fixed points, attractors and oscillations
- Check, compare and report models, including their limits

Modules

1. **Modelling principles** · Questions, assumptions, state variables, parameters and model checking
2. **Passive membrane** · RC membrane, leak, charging curves and time constants
3. **Integrate-and-fire** · Threshold, reset, refractoriness and input–output relations
4. **Conductance models** · Hodgkin–Huxley concepts, gating and conductance
5. **Synaptic interactions** · Synaptic time courses, delays, excitation, inhibition and summation
6. **Small networks** · Connectivity, recurrent interactions and population rate models
7. **Network dynamics** · Fixed points, attractors and oscillations; parameter sensitivity
8. **Evaluation and reporting** · Numerical checks, simple fitting, competing models, limits of explanation

Labs and projects: A simulation notebook each week; a reproducible comparison of two models or parameter regimes.

Books and readings: Dayan & Abbott, Theoretical Neuroscience; Gerstner et al., Neuronal Dynamics

CN202 200 · INTERMEDIATE · COMPUTATIONAL NEUROSCIENCE

Biophysical Neural Modelling

Detailed, data-driven models of real neurons and microcircuits.

Mode	Instructor-led
Term	SP2 · Mar–Apr
Duration	8 weeks · about 40 learner hours
Counts toward	Standalone course
Prerequisites	MA101.
Who it is for	Learners interested in detailed cellular and circuit modelling, including neuroscience and engineering graduate students.
Faculty	Dr. Srikanth Ramaswamy
Assessment	Assignments and a graded project.

How to build neuron models with realistic morphology and ion channels, constrain them with experimental data, and assemble them into microcircuits.

Learning outcomes

On completion you can:

- Build multi-compartment neuron models
- Model ion channels and synapses from experimental data
- Use the NEURON simulator with reconstructed morphologies
- Fit and validate model parameters
- Explain how data-driven microcircuit models are assembled

Modules

1. **The cable equation** · Passive dendrites
2. **Compartmental models** · Discretising a neuron
3. **Ion channels** · Hodgkin–Huxley and Markov channel models
4. **Morphology** · Using reconstructed neurons
5. **The NEURON simulator** · Hands-on modelling
6. **Synaptic dynamics** · Short-term plasticity
7. **Parameter fitting** · Optimisation against recordings
8. **Microcircuits** · Data-driven circuit reconstruction
9. **Validation** · Testing models against experiments

Labs and projects: NEURON simulator exercises; build and fit one cell model.

Books and readings: Sterratt et al., Principles of Computational Modelling in Neuroscience

NT201 200 · INTERMEDIATE · NEUROTECHNOLOGY

Introduction to Brain–Computer Interfaces and Neuromodulation

Neural decoding, brain–computer interfaces, brain stimulation and rehabilitation technology.

Mode	Instructor-led
Term	SP2 · Mar–Apr; FA2 · Oct–Nov repeat proposed
Duration	8 weeks · about 40 learner hours
Counts toward	PC Neurotechnology · Specialisation
Prerequisites	NT101.
Who it is for	Engineers and clinicians aiming to work on BCIs, neuro-devices or neurorehabilitation.
Faculty	Dr. Bankim Subhash Chander
Assessment	Assignments and a graded project.

The core course of the Neurotechnology certificate. It covers machine-learning-driven neural decoding, brain–computer interfaces, electrical and magnetic brain stimulation, rehabilitation robotics and the ethics of neurotechnology.

Learning outcomes

On completion you can:

- Explain the main BCI paradigms and their trade-offs
- Extract features and classify EEG for a BCI
- Evaluate a BCI with appropriate metrics
- Describe invasive BCIs and recent clinical results
- Explain the principles of TMS, tDCS and DBS, including closed-loop stimulation
- Describe technology-assisted rehabilitation, wearables and the ethics of neurotechnology

Modules

1. **Recap of NT101** · The neurotechnology pipeline, bioelectricity and electrodes
2. **Machine learning and AI for neural data** · Feature extraction; ML and deep learning; decision support
3. **Brain–computer interfaces and paradigms** · The BCI pipeline; motor imagery, P300 and SSVEP
4. **Decoding, training and interfaces** · Classification; training user and decoder; invasive interfaces
5. **Restorative BCI and neuroprosthetics** · Communication and movement BCIs; neuroprosthetics; feedback
6. **Non-invasive brain stimulation** · Electrical vs magnetic stimulation; TMS and rTMS; tDCS; tACS
7. **Invasive and closed-loop neuromodulation** · DBS and Parkinson's disease; VNS; closed-loop stimulation
8. **Neurorehabilitation, wearables and digital biomarkers** · Robotics, VR, exergaming; wearable sensors
9. **Future frontiers, neuroethics and careers** · AI-driven and implantable devices; neural privacy; careers

Labs and projects: Build a motor-imagery or SSVEP BCI on public EEG data.

Books and readings: Wolpaw & Wolpaw, Brain–Computer Interfaces

CL102 200 · INTERMEDIATE · CLINICAL

AI for Medical Analysis 2: Deep Learning and Research Frontiers

Deep learning across medical modalities, modern research methods and safe deployment.

Mode	Instructor-led
Term	SP2 · Mar–Apr
Duration	8 weeks over 2 months · about 32 hours
Counts toward	Standalone course
Prerequisites	CL101, or equivalent knowledge of data preparation, evaluation, neural networks and CNNs.
Who it is for	Learners who have completed CL101: engineers, medical students, residents and clinicians.
Faculty	Dr. Chandra Sekhar Vorugunti
Assessment	Weekly quizzes 15% · two assignments 45% · capstone 40%. 60% to pass.

Continues CL101. Learners apply deep learning across medical modalities, interpret modern research methods and assess the evidence a model needs before clinical deployment.

Learning outcomes

On completion you can:

- Apply deep learning to ECG and patient time series, and test explanations and external validity
- Describe segmentation, foundation models and large language models, including their failure modes
- Assess privacy, fairness and regulation, including the DPDP Act 2023 and ICMR guidelines
- Explain a recent CVPR or MICCAI paper in clinical terms and judge whether it would hold in a hospital
- Critically appraise a medical AI study with TRIPOD+AI, CLAIM and CONSORT-AI

Modules

1. **Deep learning for physiological signals and patient time series** · 1-D CNNs, RNNs and LSTMs
2. **Explainability, shortcut learning and external validation** · Grad-CAM, SHAP; distribution shift
3. **Segmentation and promptable foundation models** · U-Net and nnU-Net; Dice and IoU; MedSAM2
4. **Medical foundation models and vision–language models** · Transformers; CLIP; zero-shot; LoRA
5. **Generative AI, medical reasoning models and agents** · LLMs and hallucination; RAG; diffusion models
6. **Trustworthy, generalisable and deployable AI** · Uncertainty; fairness; federated learning; regulation
7. **Critical appraisal and capstone preparation** · Appraising papers; TRIPOD+AI, CLAIM and CONSORT-AI
8. **Capstone presentations and final assessment** · Paper critique, mini project or reproduction

Labs and projects: Weekly notebooks; two assignments; a capstone critique, project or reproduction.

Books and readings: Reading list of recent MICCAI, CVPR and Nature-family papers

CL201 200 · INTERMEDIATE · CLINICAL

Computational Modelling of Stroke Rehabilitation

Using models of motor learning to understand and personalise recovery after stroke.

Mode	Instructor-led
Term	SP2 · Mar–Apr
Duration	8 weeks · about 40 learner hours
Counts toward	Standalone course
Prerequisites	CS101.
Who it is for	Physiotherapists, rehabilitation clinicians, biomedical engineers and modellers.
Faculty	Neurovidya faculty
Assessment	Assignments and a graded project.

Brings together stroke neurology, motor control and computational models of learning, and asks how models can guide therapy, robotics and game-based rehabilitation.

Learning outcomes

On completion you can:

- Describe motor deficits after stroke and how recovery is measured
- Explain error-based and reinforcement models of motor learning
- Model the roles of basal ganglia and cerebellum in recovery
- Evaluate robot, VR and game-based therapies
- Propose a model-guided, personalised therapy plan

Modules

1. **Stroke and the motor system** · Lesions and deficits
2. **Measuring recovery** · Clinical scales and kinematics
3. **Motor control** · Reaching as an optimisation problem
4. **Motor learning models** · Error-based learning and reinforcement
5. **Basal ganglia and cerebellum** · Models of recovery
6. **Plasticity** · How the brain rewires
7. **Technology-assisted therapy** · Robots, VR and exergames
8. **Personalised rehabilitation** · Models as patient digital twins

Labs and projects: Simulate a reaching arm that relearns after a simulated lesion.

Books and readings: Chakravarthy & Moustafa, Computational Neuroscience Models of the Basal Ganglia (Springer)

CL202 200 · INTERMEDIATE · CLINICAL

AI for Neurology

Machine learning across neurological signals, imaging, movement and clinical records.

Mode	Instructor-led · live lecture and guided lab
Term	FA1 · August–September 2027 · proposed
Duration	8 weeks · two 90-minute sessions weekly · 24 live hours, plus independent work
Counts toward	PC AI in Clinical Neuroscience · Specialisation
Prerequisites	No prior AI course required. Week 1 introduces machine learning; CS101 or equivalent Python preparation is recommended. CL101 is helpful.
Who it is for	Neurologists, neurology residents, medical students, neurophysiology technologists, rehabilitation professionals and engineers.
Faculty	AI instructor and practising neurologist · to be confirmed
Assessment	Weekly quizzes 20% · two case assignments 40% · clinical mini project 40%. 60% to pass.

Each clinical question is examined through data, modelling, validation and workflow. Guided notebooks use public datasets and pretrained models. Learners distinguish a promising prediction from evidence of clinical benefit.

Learning outcomes

On completion you can:

- Match neurological data to suitable AI methods and evaluate sensitivity, predictive values, calibration and thresholds
- Build a seizure-detection pipeline with patient-wise validation; assess stroke imaging, tumour segmentation and digital biomarkers
- Evaluate language-model outputs and examine external validation, clinical usefulness and implementation limits

Modules

1. **AI in neurology** · Clinical questions, supervised learning, confusion matrices and calibration; first classifier on tabular data.
2. **EEG and epilepsy** · Artefacts, spike and seizure detection, alarm fatigue; CHB-MIT lab and patient-wise validation.
3. **Stroke** · CT, CTA and perfusion, haemorrhage and occlusion detection, triage thresholds; pretrained head CT classifier.
4. **Brain MRI** · Tumour segmentation, demyelination, volumetry and scanner variation; pretrained segmentation lab.
5. **Neurodegeneration** · Alzheimer's and Parkinson's biomarkers, voice, gait and progression; small-dataset limitations.
6. **Sleep and movement** · Sleep staging, EMG and nerve conduction, video movement analysis; Sleep-EDF lab.
7. **Language models and multimodal AI** · Clinical notes, guideline retrieval, hallucination and uncertainty; vignette evaluation.
8. **From model to bedside** · External and prospective validation, privacy, regulation, reporting and low-resource workflows; project presentations.

Labs and projects: Weeks 5–8, teams frame a clinical question, analyse a public dataset, evaluate errors and thresholds, and submit a report and ten-minute presentation. This course project is separate from the RP301 certificate capstone.

Books and readings: Datasets: CHB-MIT, TUH EEG, RSNA head CT, BraTS, ISLES, Sleep-EDF and Parkinson's datasets; some require registration. Readings: Topol (2019), High-performance medicine; TRIPOD+AI, CLAIM and ICMR AI ethics guidelines (2023).

CN204 200 · INTERMEDIATE · COMPUTATIONAL NEUROSCIENCE

Neural Signal Processing

From raw EEG, EMG and MEG to reliable biomarkers.

Mode	Self-paced
Term	Start anytime
Duration	7 chapters · 39 lessons
Counts toward	PC Computational Neuroscience · Specialisation
Prerequisites	CS101 recommended.
Who it is for	Engineers, neuroscientists and clinicians who work with biosignals.
Faculty	Prof. V. Srinivasa Chakravarthy
Assessment	Quizzes and a graded final assessment.

A complete self-paced course on processing the electrical signals of brain and body. Each step of the pipeline is explained, then applied to real recordings.

Learning outcomes

On completion you can:

- Explain where EEG, EMG and MEG signals come from
- Sample, filter and clean biosignals correctly
- Analyse signals in the time, frequency and time–frequency domains
- Extract features that serve as biomarkers
- Build a complete processing pipeline for a clinical question

Modules

1. **Understanding neural signals** · What a biological signal is; resting membrane and action potentials; neural signals at different scales; waveform characteristics
2. **Neural signal acquisition** · The acquisition chain; electrodes and sensors; amplification and signal conditioning; sampling and analog-to-digital conversion; electrical safety and isolation
3. **Noise, artefacts and preprocessing** · Sources of noise; physiological artefacts; stationary and nonstationary signals; basic artefact detection and removal
4. **Time and frequency domains** · Time-domain representation; why frequency-domain analysis is needed; an intuitive introduction to Fourier analysis; Fourier transform and power spectrum; sampling and the Nyquist principle; neural frequency bands
5. **Filtering neural signals** · Why signals are filtered; low-pass, high-pass, band-pass and notch filtering; moving-average and median filtering; selecting a filter for a neural application
6. **Nonstationary neural signals** · Why neural signals change with time; short-time Fourier transform; spectrograms; introduction to wavelet analysis; event-related potentials; time-locked and induced activity
7. **Applications in neuroscience** · EEG; ECoG; EMG; EOG; spikes and local field potentials; MEG; introduction to a neural signal-processing pipeline

Labs and projects: Exercises on real EEG, EMG and MEG recordings.

Books and readings: Course notes

NT210 200 · INTERMEDIATE · NEUROTECHNOLOGY

AI for EEG Bootcamp

An intensive, hands-on route to building machine-learning models on EEG.

Mode	Self-paced
Term	Start anytime
Duration	7 chapters · 37 lessons
Counts toward	PC AI in Clinical Neuroscience · Specialisation; also available independently
Prerequisites	CS101 recommended.
Who it is for	Students, researchers, engineers and healthcare professionals who want to apply AI to brain signals.
Faculty	Prof. V. Srinivasa Chakravarthy
Assessment	Quizzes and a graded project.

A practical course covering EEG data preparation, model training and evaluation of deep-learning classifiers for clinical and BCI applications.

Learning outcomes

On completion you can:

- Preprocess raw EEG for machine learning
- Engineer features for classic classifiers
- Train deep networks on EEG
- Evaluate models fairly across subjects
- Apply the pipeline to a clinical or BCI dataset

Modules

1. **EEG basics: brain signals for AI applications** · Brain structure and function; the birth of EEG; EEG recording systems; signal characteristics; types of EEG signals; data collection best practices
2. **Pre-processing: sampling and signal representation** · Introduction to signals; sampling a signal; aliasing; EEG from brain to file
3. **Pre-processing: noise and artefacts in EEG** · Noise in signals; eye blinks; identifying artefacts; removing artefacts; artefact rejection vs removal
4. **Feature extraction** · Turning signals into numbers; the brain's baseline; Hjorth parameters; line length; feature vectors
5. **Feature extraction: frequency analysis** · The hidden world of numbers; Fourier transforms; power spectral density; spectrograms; wavelet transforms; putting it all together
6. **Using machine learning with EEG** · Loss functions and model optimisation; cross-entropy and classification loss; model evaluation; ML for analysis; linear models; margin- and kernel-based models; ensemble and instance-based models
7. **Using deep learning with EEG** · The perceptron; convolutional neural networks; EEGNet; the complete pipeline

Labs and projects: Coding exercises in every chapter; capstone project.

Books and readings: Course notes

PS201 200 · INTERMEDIATE · PSYCHOLOGY & PSYCHIATRY

Introduction to Computational Psychiatry

Mental health conditions understood through reinforcement learning and deep networks.

Mode	Instructor-led or blended
Term	FA1 · August–September 2027 · proposed
Duration	8 teaching weeks; RP301 capstone separately
Counts toward	PC Computational Psychiatry · Specialisation
Prerequisites	None. In the certificate pathway, CS201 runs alongside and covers related reinforcement-learning material. Undergraduate-level mathematics is taught as needed.
Who it is for	MSc Psychology and similar students, psychiatry residents and clinical psychologists. Labs use Python; CS101 is recommended.
Faculty	Neurovidya faculty
Assessment	Lab reports, case studies and a graded final assessment.

Starting from animal behaviourism and ending at deep reinforcement learning, the course treats conditions such as depression, anxiety and addiction as changes in the parameters of a learning agent. A separate RP301 capstone develops an applied research question in computational psychiatry.

Learning outcomes

On completion you can:

- Explain reward, value and prediction error and their links to dopamine
- Fit learning models to choice data and read the parameters as a profile
- Describe how deep networks and deep RL model brains
- Model depression, anxiety, compulsivity and psychosis as altered parameters
- Discuss how parameter profiles could guide individual care and education

Modules

1. **Why computational psychiatry?** · Three traditions and hidden variables
2. **Reward, value and prediction error** · From drives to dopamine; temporal-difference learning
3. **Choice and exploration** · Fitting models to people
4. **Deep networks and deep RL** · Networks as brain models; agents realistic enough to model patients
5. **Depression, anhedonia and anxiety** · Reward sensitivity and avoidance learning
6. **Compulsivity and addiction** · Goals versus habits; delay discounting
7. **Psychosis**
8. **Neurodevelopmental conditions** · Individual learner profiles

Labs and projects: Python labs in every module, including bandit tasks and agent simulations.

Books and readings: Sutton & Barto, Reinforcement Learning; Redish & Gordon (eds.), Computational Psychiatry

PS202 200 · INTERMEDIATE · PSYCHOLOGY & PSYCHIATRY

Computational Cognitive Science

How space and language emerge from sensorimotor learning, modelled with neural networks and RL.

Mode	Instructor-led or blended
Term	FA2 · Oct–Nov · proposed
Duration	8 weeks · about 40 learner hours · 9 modules
Counts toward	Standalone course
Prerequisites	None. Undergraduate-level mathematics is taught as needed.
Who it is for	Psychology, cognitive science, linguistics, education and engineering students.
Faculty	Neurovidya faculty
Assessment	Labs and a graded final project.

A course in cognitive science based on deep networks, recurrent networks and reinforcement learning. It examines the development of spatial and linguistic representations from sensorimotor learning, alongside models of reading, dyslexia and Indian writing systems.

Learning outcomes

On completion you can:

- Build and train networks that model perception, memory and decisions
- Explain how place and grid-like codes emerge from movement
- Compare grounded and distributional models of language
- Model reading and dyslexia across English and akshara scripts
- Relate model parameters to individual learner profiles

Modules

1. **Foundations** · Networks as models of mind
2. **Decision-making and RL** · Basal ganglia, habits and memory
3. **Perception** · Vision with CNNs
4. **The sensorimotor child** · Embodied and curiosity-driven learning
5. **Space** · Place and grid codes, cognitive maps
6. **Grounded and distributional language** · From babbling to transformers
7. **Reading and dyslexia** · The triangle model and akshara scripts
8. **Multilingualism in India** · Transfer, scripts, code-switching
9. **Synthesis** · From body to space and words

Labs and projects: A training lab for every module in Python.

Books and readings: O'Reilly & Munakata, Computational Cognitive Neuroscience; Sutton & Barto, Reinforcement Learning

MA301 300 · ADVANCED · MATHEMATICS

Advanced Statistics for Neuroscience

The modern statistical toolkit for complex neuroscience and clinical data.

Mode	Instructor-led
Term	SP2 · Mar–Apr
Duration	8 weeks · about 40 learner hours
Counts toward	Standalone course
Prerequisites	MA101 or MA103.
Who it is for	Graduate students, researchers and clinicians analysing their own data.
Faculty	Dr. R. Vignayanandam Mudappu
Assessment	Assignments and a graded project.

Designed for learners with basic statistical training who require methods for hierarchical, high-dimensional and time-series data, with emphasis on rigorous and reproducible analysis.

Learning outcomes

On completion you can:

- Fit and interpret generalised linear and mixed-effects models
- Run Bayesian analyses and check them
- Control error rates with permutation and cluster-based methods
- Compare models with cross-validation and information criteria
- Plan well-powered, reproducible studies

Modules

1. **Generalised linear models** · Counts, proportions, spikes
2. **Mixed-effects models** · Subjects, trials, sessions
3. **Bayesian inference** · Priors, posteriors, MCMC
4. **Multiple comparisons** · Permutation and cluster tests
5. **Model comparison** · AIC, BIC, cross-validation
6. **Time series** · Autocorrelation and state-space models
7. **Power and reproducibility** · Pre-registration, effect sizes

Labs and projects: Analyses in Python and R on neuroscience datasets.

Books and readings: Gelman et al., Regression and Other Stories

CN301 300 · ADVANCED · COMPUTATIONAL NEUROSCIENCE

Dynamical Neuroscience

The mathematics of how neural systems change in time.

Mode	Instructor-led
Term	FA1 · Aug–Sep · proposed
Duration	8 weeks · about 40 learner hours
Counts toward	Advanced Professional Certificate (planned)
Prerequisites	CN201.
Who it is for	Learners with the Computational Neuroscience certificate or equivalent.
Faculty	Neurovidya faculty
Assessment	Assignments and a graded project.

Dynamical-systems tools applied to neurons, circuits and trained recurrent networks: how stable states, oscillations and chaos arise, and what they compute.

Learning outcomes

On completion you can:

- Analyse fixed points, stability and bifurcations
- Explain how oscillations and synchrony arise in coupled systems
- Study the dynamics of trained recurrent networks
- Model large-scale activity with neural fields

Modules

1. **Dynamical systems review** · Phase space and stability
2. **Bifurcations** · How neurons switch behaviour
3. **Oscillators** · Phase reduction and synchrony
4. **Attractors** · Line, ring and continuous attractors
5. **Chaos** · Chaotic networks and balance
6. **Recurrent networks** · Reverse-engineering trained RNNs
7. **Neural fields** · Waves and patterns in cortex

Labs and projects: Simulation projects in Python.

Books and readings: Strogatz, Nonlinear Dynamics and Chaos; Ermentrout & Terman, Mathematical Foundations of Neuroscience

CN302 300 · ADVANCED · COMPUTATIONAL NEUROSCIENCE

Learning, Decision Making and Motor Control

How brains learn from reward, choose between options and control movement.

Mode	Instructor-led
Term	FA1 · Aug–Sep · proposed
Duration	8 weeks · about 40 learner hours
Counts toward	Advanced Professional Certificate (planned)
Prerequisites	CN201.
Who it is for	Learners with the Computational Neuroscience certificate or equivalent.
Faculty	Neurovidya faculty
Assessment	Assignments and a graded project.

Reinforcement learning, decision models and motor control, connected to the basal ganglia, cerebellum and cortex, and to the disorders that follow when these circuits fail.

Learning outcomes

On completion you can:

- Model learning with temporal-difference RL and relate it to dopamine
- Build basal ganglia models of action selection
- Fit drift–diffusion models to choices and reaction times
- Explain optimal feedback control and cerebellar learning
- Relate model failures to Parkinson's disease and other disorders

Modules

1. **Reinforcement learning** · TD learning and dopamine
2. **Basal ganglia** · Action selection and Go/NoGo models
3. **Decision making** · Evidence accumulation and drift–diffusion
4. **Motor control** · Optimal feedback control
5. **The cerebellum** · Internal models and adaptation
6. **Motor learning** · Skill and adaptation
7. **Disorders** · Parkinson's disease and beyond

Labs and projects: Simulation projects in Python.

Books and readings: Chakravarthy & Moustafa, Computational Neuroscience Models of the Basal Ganglia (Springer); Sutton & Barto, Reinforcement Learning

CN303 300 · ADVANCED · COMPUTATIONAL NEUROSCIENCE

Systems Neuroscience Modelling

Models of perception, attention, memory and navigation.

Mode	Instructor-led
Term	FA1 · Aug–Sep · proposed
Duration	8 weeks · about 40 learner hours
Counts toward	Advanced Professional Certificate (planned)
Prerequisites	CN201.
Who it is for	Learners with the Computational Neuroscience certificate or equivalent.
Faculty	Neurovidya faculty
Assessment	Assignments and a graded project.

How whole brain systems are modelled, and how those models are tested against behaviour and neural recordings.

Learning outcomes

On completion you can:

- Model the visual system with deep and oscillatory networks
- Explain computational models of attention and working memory
- Model the hippocampus, place and grid cells
- Compare models with brain data using representational analyses

Modules

1. **Vision** · Ventral stream and deep networks
2. **Attention** · Normalisation and gain models
3. **Working memory** · Persistent activity and its alternatives
4. **Hippocampus** · Memory and replay
5. **Navigation** · Place, grid and head-direction cells
6. **Basal ganglia** · Action selection, gait and reaching
7. **Language and cognition** · Network models
8. **Testing models** · Representational similarity and beyond

Labs and projects: Simulation and analysis projects in Python.

Books and readings: O'Reilly & Munakata, Computational Cognitive Neuroscience

CN304 300 · ADVANCED · COMPUTATIONAL NEUROSCIENCE

Machine Learning and Deep Learning for Neuroscience

Machine learning and deep learning for neuroscience, and neuroscience for AI.

Mode	Instructor-led
Term	FA2 · Oct–Nov · proposed
Duration	8 weeks · 12 live sessions of 90 minutes
Counts toward	Advanced Professional Certificate (planned)
Prerequisites	None. Python is taught from Week 1; CS101 helpful.
Who it is for	Researchers and students in neuroscience, medicine, physics and engineering, from Python beginners to experienced analysts.
Faculty	Dr. Chandra Sekhar Vorugunti
Assessment	Weekly homework, project milestones and a capstone: reproducible notebook, short report and presentation.

Learners study machine-learning and deep-learning methods for neural data analysis and examine how artificial networks can inform models of brain function.

Learning outcomes

On completion you can:

- Run a leakage-free ML workflow with subject-wise validation
- Choose, compare and tune classical models for neuroscience questions
- Build MLPs, CNNs and RNNs in Keras for EEG, image and sequence data
- Use bio-inspired RNNs and pretrained foundation models as models of the brain
- Interpret models with SHAP and saliency, and report results reproducibly

Modules

1. **Python for neuroscience data** · NumPy, pandas and plotting with EEG, behaviour and connectivity data
2. **Neuro data types and feature extraction** · ERPs and band power; fMRI connectivity; images and spikes
3. **The ML workflow and neural decoding** · Cross-validation and metrics; data leakage; a BCI decoder
4. **Choosing models** · Regression, k-NN, SVM, trees, random forests, boosting; assumptions and limitations
5. **High-dimensional data and feature selection** · Ridge, Lasso; connectome-based predictive modelling
6. **Unsupervised learning and pattern discovery** · PCA; clustering; t-SNE and UMAP; neural trajectories
7. **Neural networks with Keras** · Backpropagation, dropout, early stopping; when deep learning helps
8. **CNNs for microscopy images and EEG** · Transfer learning; augmentation; EEGNet-style models
9. **RNNs, neural dynamics and statistical mechanics** · LSTMs and GRUs; attractors; Hopfield networks
10. **Bio-inspired RNNs and foundation models** · E/I-constrained RNNs; in-silico lesions; transformers
11. **Interpretation, reproducibility and pitfalls** · SHAP and saliency; leakage; reproducible pipelines
12. **Capstone presentations** · Learner projects, from research question to limitations

Labs and projects: scikit-learn and Keras notebooks every session; capstone on own or public data.

Books and readings: Géron, Hands-On Machine Learning; Chollet, Deep Learning with Python

CN305 300 · ADVANCED · COMPUTATIONAL NEUROSCIENCE

Translational Computational Neuroscience

Clinical applications of computational neuroscience models.

Mode	Instructor-led
Term	FA2 · Oct–Nov · proposed
Duration	8 weeks · about 40 learner hours
Counts toward	Advanced Professional Certificate (planned)
Prerequisites	CN201.
Who it is for	Learners with the Computational Neuroscience certificate, clinicians with modelling experience.
Faculty	Neurovidya faculty
Assessment	Assignments and a graded project.

How computational models are used to understand disease, design therapies and personalise treatment, with case studies in movement disorders, epilepsy, stroke and psychiatry.

Learning outcomes

On completion you can:

- Build disease models of Parkinson's disease and epilepsy
- Use models to design and optimise brain stimulation
- Explain digital twins and whole-brain models
- Evaluate how models can be validated clinically

Modules

1. **Models of disease** · Principles and pitfalls
2. **Parkinson's disease** · Basal ganglia models and DBS
3. **Epilepsy** · Seizure dynamics and prediction
4. **Stroke** · Models of damage and recovery
5. **Psychiatry** · Computational phenotypes
6. **Digital twins** · Whole-brain and patient-specific models
7. **Clinical validation** · From simulation to trial

Labs and projects: Case-study projects with disease models.

Books and readings: Chakravarthy & Moustafa, Computational Neuroscience Models of the Basal Ganglia (Springer)

MICROCOURSES

Self-paced microcourses

Microcourses provide concise introductions to specific topics, typically through an hour of study or a short sequence of chapters. Each awards a standalone Course Certificate and does not contribute towards a Professional Certificate.

NT105 · AI for EEG

5 chapters · 5 lessons · Self-paced · Course Certificate

A concise introduction to machine learning for EEG, covering data preparation, analysis workflows, applications and limitations.

1. **Introduction to electroencephalography (EEG)** · EEG fundamentals: understanding brain signals
2. **EEG frequency bands** · Delta, theta, alpha, beta and gamma
3. **EEG signal pre-processing** · From raw signals to analysis-ready data
4. **EEG feature extraction** · Turning brain signals into meaningful information
5. **Machine learning and deep learning for EEG** · Applying ML and DL techniques to EEG

NT100 · Neurotechnology Microcourse

7 lessons · about 60 minutes · Self-paced · Course Certificate

An hour-long overview of neurotechnology, from electrodes to brain–computer interfaces.

1. **What is neurotechnology?** · Recording, decoding and modulation
2. **Recording the nervous system** · EEG, EMG and peripheral nerve recording
3. **Imaging the brain** · Structural vs functional imaging: CT, MRI, fMRI, PET
4. **From neural signals to information** · Digitisation, preprocessing and feature extraction
5. **Brain–computer interfaces and neuroprosthetics** · Motor imagery, P300 and SSVEP
6. **Modulating the nervous system** · TMS, tDCS, tACS, DBS, VNS and closed-loop systems
7. **Where is neurotechnology going?** · Wearables, AI decoding and responsible development

CN120 · Neural Oscillators

4 chapters · 6 lessons · Self-paced · Course Certificate

How neurons and networks produce rhythms, with simple oscillator models and their links to brain waves.

1. **Introduction to neural oscillators**
2. **Dynamical systems** · Modelling oscillators; linear dynamics in 2-D
3. **Nonlinear dynamics**
4. **Oscillatory neuron models** · Single-neuron models; ensemble neuron models

CL110 · Human Movement Analysis

3 chapters · 3 lessons · Self-paced · Course Certificate

Measuring and analysing human movement with motion capture and sensors, for research and rehabilitation.

1. **What is human movement?** · Why movement matters and where movement analysis is used
2. **How movement becomes data** · Sensors and motion-capture technologies
3. **From movement to intelligence** · Feature extraction and how AI interprets movement

MA050 · Mathematics Primer for Medicos

8 chapters · 35 lessons · Self-paced · Course Certificate

The mathematics behind biology and medicine, from functions, vectors and matrices to dynamics, statistics, signals and learning. Also the bridge course to MA101; the full syllabus is under MA050 in the course syllabi.

1. **The language of mathematics** · Measurement, variables and functions as models
2. **Representing biological information** · Data types, vectors and tables
3. **Vectors, matrices and biological systems** · Transformations and network matrices
4. **Calculus and dynamical systems** · Derivatives, integrals and differential equations
5. **Dynamical systems in biology** · Equilibrium, stability and feedback
6. **Statistics and probability** · Variability, uncertainty, hypothesis testing and regression
7. **Signal processing** · Time series, frequency and filtering for EEG and ECG
8. **Learning and optimisation** · Loss functions, gradient descent and neural networks

CS100 · Python for Neuroscience

4 chapters · 4 lessons · Self-paced · Course Certificate

Python fundamentals for scientific computing, from operators and collections to NumPy and pandas, applied to neuroscience data. A short starting point before the full CS101 course.

1. **Introduction to Python** · Fundamentals of Python
2. **Operators and expressions** · Arithmetic, logical and comparison operators
3. **Collections and data structures** · Collections, tuples and dictionaries
4. **Scientific Python libraries** · NumPy arrays and pandas data frames

RESEARCH TRAINING PROJECTS

Mentored research training

Research Training Projects connect learners with Neurogati researchers to investigate defined questions. Available topics are published each term and cover modelling, data analysis, neurotechnology and clinical computation.

RP101 · Research Training Project · 1 month

Term: WI · December · Prerequisites: Per project menu

A short mentored project, ideal alongside the Winter School. Earns a project certificate.

RP201 · Research Training Project · 2 months

Term: SP1, SP2, FA1, FA2 · Prerequisites: Relevant foundation course

A term-long project on a defined research question, with weekly mentoring.

RP301 · Research Training Project · 3 months

Term: SU · May–Jul, or FA2 + WI · Prerequisites: Certificate foundation and specialisation courses; fall projects (FA2 + WI) start alongside the specialisation courses

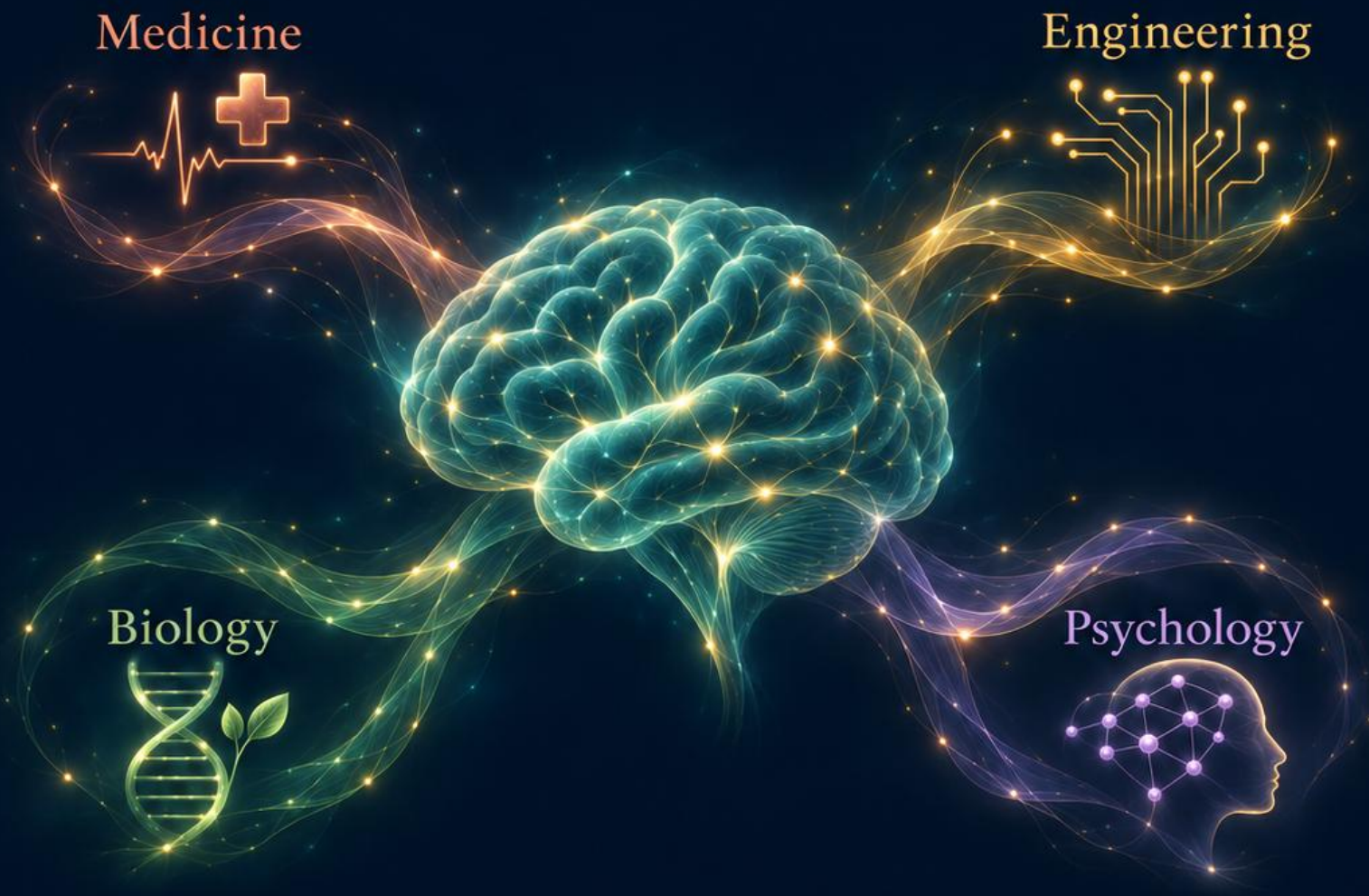
The capstone for the Professional Certificate pathways, with a project in the chosen specialisation. Learners carry out a full project, from question to written report and presentation.

Every project includes

- A clear research question and plan agreed at the start
- Weekly mentoring meetings
- Code and data kept in a shared repository
- A written report and a final presentation
- Assessment of the report, the work and the presentation

NEUROVIDYA

Four ways into Neuroscience



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