Neurosciences Concentration

Symbolic Systems majors completing the new Core requirements effective for 2020-2021 must complete the following requirements to qualify for a Concentration in Neurosciences. All courses must be taken for 3 units of more. Notes: Core requirements fulfilled by a course are noted in brackets "[]". "ASSR" denotes courses that fulfill the Advanced Small Seminar Requirement.

Students in the Neurosciences Concentration must take a total of five courses. At least two of the five courses must be from the first two areas, and at least one must come from area 8. If any of the courses listed under areas 1-8 are taken for Core requirements, then additional approved Contingent Elective courses (see area 9) must be completed to total 5 courses beyond those that are taken for the Core. Area 10 (Recommended Add-ons) consists of one- and two-unit courses that supplement areas 1-9. Add-on courses do not count toward the 5-course requirement for the Concentration.

1. **Basic Neuroscience.**
   - BIO 84: Physiology
   - BIO 86: Cell Biology
   - BIO 150: Human Behavioral Biology (BIO 250, HUMBIO 160) [*Cognition Language & Neuroscience*]
   - BIO 151: Mechanisms of Neuron Death [ASSR]
   - BIO 153: Cellular Neuroscience: Cell Signaling and Behavior (PSYCH 120)
   - BIO 154: Molecular and Cellular Neurobiology
   - HUMBIO 4A: The Human Organism
   - NBIO 206: The Nervous System (NBIO 206 is a 6-unit course which counts as two concentration courses, from areas 1 and 2:)
   - PSYCH 121: Ion Transport and Intracellular Messengers (PSYCH 228)

2. **Systems neuroscience.**
   - BIO 158: Developmental Neurobiology (BIO 258)
   - BIO 222: Exploring Neural Circuits
   - EDUC 266: Educational Neuroscience
   - PSYC 124: Brain Plasticity
   - PSYCH 30: Introduction to Perception [*Cognition Language & Neuroscience*]
   - PSYCH 45: Introduction to Learning and Memory [*Cognition Language & Neuroscience*]
   - PSYCH 50: Introduction to Cognitive Neuroscience [*Cognition Language & Neuroscience*]
   - PSYCH 141: Cognitive Development [*Cognition Language & Neuroscience*]
   - PSYCH 154: Judgment and Decision Making [*Cognition Language & Neuroscience*]
PSYCH 162: Brain Networks (PSYCH 267) [ASSR]
PSYCH 169: Advanced Seminar on Memory [ASSR]
PSYCH 205: Foundations of Cognition
PSYCH 232: Brain and Decision Making [ASSR]
PSYCH 254: Affective Neuroscience (previously offered as PSYCH 251) [ASSR]
PSYCH 266: Current Debates in Learning and Memory [ASSR]

3. Computational Approaches.
   - BIOE 101: Systems Biology (BIOE 210)
   - BIOE 300B: Quantitative Physiology
   - EE 124: Introduction to Neuroelectrical Engineering
   - CS 223A: Introduction to Robotics (ME 320)
   - CS 229: Machine Learning
   - CS 379C: Computational Models of the Neocortex
   - MATSCI 384: Materials Advances for Neurotechnology: Materials Meet the Mind
   - MUSIC 257: Neuroplasticity and Musical Gaming
   - PSYCH 164: Brain Decoding [Cross-Area Requirement]
   - PSYCH 204: Computation and Cognition: the Probabilistic Approach [Cross-Area Requirement]
   - PSYCH 204A: Human Neuroimaging Methods
   - PSYCH 204B: Computational Neuroimaging: Analysis Methods
   - PSYCH 209: Neural Network and Deep Learning Models for Cognition and Cognitive Neuroscience [Cross-Area Requirement]
   - PSYCH 249: Large-Scale Neural Network Modeling for Neuroscience (CS 375) [Cross-Area Requirement]
   - PSYCH 287: Brain Machine Interfaces: Science, Technology, and Application (NSUR 287)
   - STATS 220: Machine Learning Methods for Neural Data Analysis (NBIO 220, STATS 320)

4. Biological and Computational Approaches to Vision.
   - CS 131: Computer Vision: Foundations and Applications
   - CS 231A: Introduction to Computer Vision
   - CS 231N: Convolutional Neural Networks for Visual Recognition
   - PSYCH 30: Introduction to Perception [Cognition Language & Neuroscience]
   - PSYCH 221: Image Systems Engineering (SYMSYS 195I) [Practicum, Integrative Requirement]
   - PSYCH 250: High-Level Vision: From Neurons to Deep Neural Networks [ASSR]

5. Philosophical and Theoretical Approaches.
   - NBIO 101: Social and Ethical Issues in the Neurosciences (NBIO 201)
   - PHIL 167D: Philosophy of Neuroscience (PHIL 267D, SYMSYS 167D) [Advanced Philosophy, Cross-Area Requirement]
6. **Methodological Foundations.**

- BIOE 291: Principles and Practice of Optogenetics for Optical Control of Biological Tissues
- CS 448B: Data Visualization (SYMSYS 195V) *[Cross-Area Requirement, Practicum, Integrative Requirement]*
- EE 102A: Signal Processing and Linear Systems I
- EE 102B: Signal Processing and Linear Systems II
- EE 261: The Fourier Transform and Its Applications
- EE 263: Introduction to Linear Dynamical Systems (CME 263)
- MATH 113: Linear Algebra and Matrix Theory
- MS&E 211: Linear and Nonlinear Optimization
- PSYCH 187: Research Methods in Cognition & Development [ASSR]
- PSYCH 204A: Human Neuroimaging Methods
- PSYCH 251: Experimental Methods (SYMSYS 195E) *[Practicum, Integrative Requirement]*
- PSYCH 253: Advanced Statistical Modeling *[Cross-Area Requirement]*
- STATS 110: Statistical Methods in Engineering and the Physical Sciences *[Probability and Statistics]*
- STATS 141: Biostatistics (BIO 141)
- STATS 191: Introduction to Applied Statistics
- STATS 200: Introduction to Statistical Inference

7. **Integrative Requirement.** Must be completed no earlier than the Junior Year:

- Any of the *Standard Options* for all Concentrations specified under the Core Capstone requirement, or
- A *Concentration-Specific Integrative Course* -- a course that integrates the themes of the Concentration with the Core requirements. One of the following [with more options to be added as they are approved -- some options may be removed if they are included in the list of SYMSYS 195* project courses, in order to avoid redundancy with the Standard Options]:
  - CS 131: Computer Vision: Foundations and Applications
  - CS 221: Artificial Intelligence: Principles and Techniques *[Post-CS 106B Computation]*
  - CS 228. Probabilistic Graphical Models: Principles and Techniques
- CS 229: Machine Learning [*Post-CS 106B Computation, Cross-Area Requirement*]
- CS 230: Deep Learning
- CS 231A: Computer Vision: From 3-D Reconstruction to Recognition
- CS 234: Reinforcement Learning
- CS 379C: Computational Models of the Neocortex
- PHIL 167D: Philosophy of Neuroscience (PHIL 267D, SYMSYS 167D) [*Advanced Philosophy, Cross-Area Requirement*]
- PHIL 357: Research Seminar in Logic and Cognition [ASSR]
- PHIL 360: Grad Seminar: Philosophy of Neuroscience [ASSR]
- PSYC 223B: Topics in Neurodiversity: Design Thinking Approaches
- PSYCH 121: Ion Transport and Intracellular Messengers (PSYCH 228) [ASSR]
- PSYCH 162: Brain Networks (same as PSYCH 267) [ASSR]
- PSYCH 164: Brain Decoding [*Cross-Area Requirement*]
- PSYCH 169: Advanced Seminar in Memory [ASSR]
- PSYCH 202: Cognitive Neuroscience
- PSYCH 204: Computation and Cognition: the Probabilistic Approach [*Cross-Area Requirement*]
- PSYCH 204A: Human Neuroimaging Methods
- PSYCH 204B: Computational Neuroimaging
- PSYCH 209: Neural Network and Deep Learning Models for Cognition and Cognitive Neuroscience [*Cross-Area Requirement*]
- PSYCH 232: Brain and Decision Making [ASSR]
- PSYCH 242: Theoretical Neuroscience (same as APPPHYS 293) [*Cross-Area Requirement*]
- PSYCH 247: Topics in Natural and Artificial Intelligence [ASSR]
- PSYCH 249: Large-Scale Neural Network Modeling for Neuroscience (same as CS 375) [*Cross-Area Requirement*]
- PSYCH 254: Affective Neuroscience [ASSR]
- STATS 220: Machine Learning Methods for Neural Data Analysis (NBIO 220, STATS 320)
- SYMSYS 202: Theories of Consciousness [ASSR]
- SYMSYS 205: The Philosophy and Science of Perception [ASSR]
- SYMSYS 245: Cognition in Interaction Design [ASSR]

8. **Contingent Electives.** If any of the courses listed under areas 1-6 are taken for Core requirements, then additional approved Contingent Elective courses must be completed to total 5 courses beyond those that are taken for the Core. These electives can be one or more courses from any of the areas above, or which are approved for a Core requirement that the student has fulfilled with a different course, or any of the following:
   - Additional courses may be added here in the future
9. **Recommended Add-ons.** One- and two-unit courses that supplement the offerings above. These courses are recommended, but do not count toward the 5-course requirement for the Concentration:

- NSUR 239: NeuroTech Training Seminar (STATS 242)
- NSUR 249: Experimental Immersion in Neuroscience (STATS 249)