NC STATE UNIVERSITY Humanities and Social Sciences

APPLICATION FOR ADMISSION

Interdisciplinary Self-Design Major, Bachelor of Science (B.S.)
Major/Curriculum Code: 16LSMBS
Interdisciplinary Studies (IDS), College of Humanities and Social Sciences
North Carolina State University, Raleigh, NC 27695-7107

___ Mark ("X") if applying to *change* your major to IDS Self-Design B.S.

X

___ Mark ("X") if applying to *add* IDS Self-Design B.S. as an additional major.

Printed name of Student: _____

Student ID Number: _____ Phone number: _____

Email address: _____

Present curriculum: PY / CE Class: 2021

Proposed title of IDS concentration: Artificial and Human Cognition

_____

Signature of Student: _____ Date: _____

Printed name of Faculty Sponsor: _____

Sponsor's department: Electrical Engineering

Sponsor's campus address: _____ Box #: _____

Sponsor's phone: _____ Email: _____

Signature of Sponsor: _____ Date: _____

Sponsor's responsibilities are listed on the IDS Self-Design FAQ webpage #11:
https://ids.chass.ncsu.edu/studies/selfdesign/FAQ.php

Mark ("X") if the student applicant is in one of these dual-degree programs

___ Thomas Jefferson Scholars

___ Benjamin Franklin Scholars

___ Alexander Hamilton Scholars

Required application materials

- A completed application form.
- A description of your concentration. Explain how you became interested in the concentration and why you want to incorporate courses from different disciplines.
- A list of courses in your concentration. Include course numbers, titles, catalog descriptions.
- A list of learning outcomes with identification of the courses you will take to help you achieve the outcomes. Courses representing different disciples will confirm the interdisciplinary approach to your learning.
- A semester-by-semester plan showing how you expect to complete all of the courses required for your Interdisciplinary Studies Self-Design degree.
- A copy of your degree audit.
- A copy of your unofficial transcript.

CONCENTRATION TITLE Artificial and Human Cognition

I. MAJOR CONCENTRATION – DEPARTMENTAL REQUIREMENTS (24 credit hours and IDS 490*)

Number	Course Title	Hours	Grade**
PSY 430	**Biological Psychology**	3	S
PSY 420	Cognitive Processes	3	A+
BIO 488	Neurobiology	3	IP
PHI 325	Biomedical Ethics	3	
CSC 411	Introduction to Artificial Intelligence	3	IP
PHI 425	Introduction to Cognitive Science	3	
BME 512	Biomedical Signal Processing	3	
ENG 210	Introduction to Language and Linguistics	3	IP
	400-level required on above line (at least two 400-level courses required)		
IDS 490	**Interdisciplinary Methods and Issues (Capstone)**	3	

* In addition to IDS 490, 24 hours of courses with no more than 15 credit hours from a single discipline required (C- or better in each course). No more than 12 transfer hours allowed. At least 5 courses must be from the humanities and social sciences, including economics courses, courses on the General Education Program (GEP) Humanities and Social Sciences lists, with at least 3 courses offered by the College of Humanities & Social Sciences (H&SS). At least 2 of the courses must be at the 400 level. The Bachelor of Science degree also includes a 15-hour Advanced Science/Technology requirement (page 5). Proposals will be reviewed by a faculty sponsor and approved by the IDS Self-Design committee.

**If you are currently enrolled in the course, put IP (In Progress) in this column. If you have not taken or are not taking the course now, leave this line blank.

II. COLLEGE OF HUMANITIES AND SOCIAL SCIENCES ("H&SS") REQUIREMENTS

Students are responsible for selecting courses required by the College of Humanities and Social Sciences. Courses should be carefully selected to meet each of the requirements listed below. While the major concentration courses listed above cannot be changed without written approval, you can make changes to the college and university required courses below as long as they meet the requirements. Please also keep in mind that the Committee's approval of your major does not constitute approval of your selection of courses to meet the College of Humanities and Social Sciences or General Education Program (GEP) requirements.

For more information see Key Points, scroll to the Student Resources section. Also, on your online degree audit click on "Rqmnt Details" links to verify approved courses for each category.

Please put a course number on every line below. If you are now taking the course, put "IP" in the "Grade" column. If you have not yet taken the course, leave a blank in the grade column.

A. Mathematics (9 hours)	Course	Hours	Grade
Calculus (3 credit hours)	MA 242	3	A+
Math Electives (6 credit hours)	MA 141	3	CR
	MA 241	3	

B. Basic (Natural) Science (16 hours)	Course	Hours	Grade
Basic/Natural Sciences: 12 credit hours from three different areas (4 hours each from Physics, Biological Sciences, Chemistry, or Earth Sciences)	CH 101 /102	4	
	BIO 183	4	
	PY 201	4	
Basic Science Elective (4 credit hours)	PY 202	4	A

C. Advanced Science/Technology (15 hours)

See required, separate form for all H&SS Bachelor of Science majors (page 5)

D. Humanities and Social Sciences* (28 hours)	Course	Hours	Grade
ENG 101: Academic Writing and Research	ENG 101	4	CR
History (one course)	HI 253	3	
Literature (one course)	HON 202	3	
Philosophy (one course)	HON 341	3	
Arts & Letters (one course)	ADN 212	3	IP
Writing and Communication (one course)	COM 110	3	
Social Sciences: 9 credit hours from three different areas (anthropology, economics, political science, psychology, sociology, or multidisciplinary)	HON 295	3	A+
	ANT 261	3	
	EC 205	3	

E. Free Electives (optional to list specific courses here; limit of 12 credit hours of S/U; may include courses for academic minors or other majors; approximately 15 hours required in order to reach 120 total degree hours required for this major)

Course number	Course title	Hours	Grade
ECE 404	Introduction to Solid-State Devices	3	A-
BME 522	Medical Instrumentation	3	
ST 501	Fundamentals of Statistical Inference I	3	B
CSC 316	Introduction to Data Structures	3	
CSC 226	Discrete Mathematics for Computer Scientists	3	
ECE 505	Neural Interface Engineering	3	IP

III. GEP REQUIREMENTS* (NCSU General Education Program, 10 hours)

	Course	Hours	Grade
GEP Health & Exercise Studies (2 units)	HESF 112	1	
At least one 100-level fitness course required	HESF 279	1	A+
GEP Additional Breadth MSNSE (3 units)	MA 242	4	
GEP Interdisciplinary Perspectives (5 units)	PHI 325		waived-in concentration
Possible waiver(s) if taken as a major/dept req	PHI 425		
GEP US Diversity (0 units) [verify requirement met]	HON 295	3	
Must be taken if not met elsewhere in degree			
GEP Global Knowledge (0 units) [verify req met]	HON 295	3	
Must be taken if not met elsewhere in degree			
Foreign Language Proficiency (0 units) [verify req met]	FLS 100	3	AP
See Key Points* for more information			

*Key Points Curriculum Guide: scroll down to "Student Resources." Also, on your online degree audit, click "Rqmnt Details" links to verify approved courses for each category.

REQUIRED TOTAL DEGREE CREDIT HOURS **120.00 units/credit hours**

IV. APPROVAL

_____ _____

Signature of IDS Self-Design Program Coordinator & Academic Advisor Date

Additional information can be obtained from the student's MyPack online degree audit, NCSU Registration & Records Degree Requirements (choose Humanities & Social Sciences and scroll to Interdisciplinary Studies-16LSMBS), and the IDS B.S. Self-Design Semester-by-Semester Plan, which provides more details for this major with its footnotes.

NC STATE UNIVERSITY Humanities and Social Sciences

ADVANCED SCIENCE/TECHNOLOGY REQUIREMENT FOR BACHELOR OF SCIENCE (B.S.) DEGREES

A 15-hour concentration in ONE area of science, technology, or mathematics is required. A minimum GPA of 2.0 is required in this group of courses. Approval of the selected courses will be indicated by the signatures of the student, his/her advisor, the department's B.S. program coordinator (if different from the advisor), and the College of Humanities & Social Sciences Associate/Assistant Dean.

Student's Name Printed: _____

Student's Identification Number: _____

This concentration is being met by: X Second Major ____ Minor ____ Thematic Focus*

*Courses for a proposed Thematic Focus should be selected in consultation with the student's advisor and should demonstrate coherence and progression in the area of study. It is expected that at least one course will be at the 300-level or higher. The following courses should not be included in a Thematic Focus: BIO < 181, CH 100, MA < 114, MEA 100, PY < 201, or ST < 300. Submissions containing a Thematic Focus that consists of courses with more than one course prefix must be accompanied by a statement from the student providing a justification for how the courses meet the requirement.

Name of 2nd Major, Minor, or Thematic Focus: Physics

**Course number	Course title	Hours	Grade
PY 412	Mechanics II	3	B+
PY 413	Thermal Physics	3	
PY 414	University Physics 3	4	
PY 401	Quantum Physics I	3	A-
PY 411	Mechanics I	3	

Student's signature: _____ Date: _____

** Students may NOT double count courses towards the Advanced Science/Technology Requirement and any other requirement. Courses on this list will be moved to the Advanced Science/Technology section of your degree audit upon Dean's Office approval of this form.

Approval:

Faculty Sponsor/Mentor: _____ Date: _____

Program Advisor/Coordinator: _____ Date: _____

H&SS Assistant /Associate Dean: _____ Date: _____

Artificial and Human Cognition: Concentration Essay

Someone once told me, "You have too many interests"—but what he probably meant (as a potential investor, waiting for me to finish a product demo) was that I have too many *passions*—that I have more than one thing I find so arresting, so fundamental, that I want to spend my life exploring it. By my estimation, I have three: human cognition, artificial intelligence, and fundamental physics. I am in college primarily to lay the foundations for those interests; I can do so for physics with an undergraduate degree. Here, I'd like to address the other two.

I didn't begin college with these priorities. I came to State thinking I'd study electrical engineering and physics—precursors, I imagined, to a PhD in neuroscience—and only discovered artificial intelligence as a Sophomore. I began to spend most of my free time (and, sneakily, a good bit of my scheduled time) bringing myself up-to-date on AI's state of the art: reading countless papers, implementing models, and starting NC State's AI Club.

What became apparent later in my study of AI—as I moved from implementations, to algorithms, to the axioms beneath them—was human cognition's role as its muse. Indeed, many researchers in the field (including deep learning's "founding fathers") recognize a key disparity between current methods of deep learning and the future of a more general AI: it is not "smart" in the way humans are; it is limited insofar as it does not exhibit human cognitive principles. Consequently, the bridge between our current linear-algebraic formalisms and true

intelligence—or even, eventually, superintelligence—lies in the intersection between human and artificial cognition.

This is where the Humanities step in. Cognitive science is a famously interdisciplinary field, pulling from philosophy, psychology, linguistics, neuroscience, artificial intelligence, and other disciplines. Psychological theory informed the creation of early neural networks (e.g., Hebb), and high-level cognitive insights continue to refine deep-learning models—as, for example, when Google incorporated Lashley's hypothesis of task analysis into modern reinforcement learning (as recently as 2019, for what feels like low-hanging fruit). Making slight improvements to a model so that you increase the state-of-the-art accuracy by 0.01% is not always an interdisciplinary endeavor, but truly *innovating* in AI is.

This is not, however, the only reason I wish to study human cognition in concert with AI. There exists an important lemma to AI's cognitive-scientific future: that we might eventually design a self-optimizing system capable of *surpassing* human cognition. Personally, I view this as an inevitability (an essay in itself), and as a source of much existential malaise: humanity's role in a world of superhuman intelligence would be uncertain at best.

I see a solution in *interfacing* human and artificial cognition. If we can achieve a sufficiently complex and seamless integration between cognitions, then the Singularity becomes a *human* event—surely one with its own set of dangers, but perhaps more interpretable ones. This also creates an opening for electrical engineering: the physical hardware of these brain-computer interfaces, collecting signals and cleaning them before attempting to understand them downstream.

This idea introduces another Humanitarian fulcrum: ethics. An ethicist might point out that magically granting a toddler the intellect of an adult wouldn't guarantee a model citizen. How should this technology be developed? How should it be *distributed*? The difference between Singularity as new Enlightenment and as high-amplitude disaster is fundamentally an ethical one.

Of course, achieving useful brain-computer interfaces between artificial and human cognition has far more obviously ethical, and far simpler, applications: the treatment of brain diseases and physical disabilities. Brain-computer interfaces are already helping the physically disabled move wheelchairs and operate robotic arms; more complex ones may be able to help people with degenerative brain diseases retain their autonomy.

The *only* way for me to effectively study the ethical interfacing of artificial and human cognition is through an interdisciplinary major. How else can I study cognitive-scientific principles and apply them to computer-scientific and engineering endeavors, in a way that is ethically sound? This is a problem, and a field, that demands interdisciplinarity at its core. Pretending otherwise—projecting myself onto one or two axes: computer science? Philosophy?—would merely hamstring my ability to learn.

The true interdisciplinary nature of this major would be exemplified in its capstone project. I could complete a project under my advisor, Dr. , as an independent study and alongside his course on brain-computer interfaces: building a brain-computer interface from scratch, and using the signals it collects to teach an artificially intelligent model. I could pick my area of the brain based on an extant problem, probably one related to physical disability.

At this point, I've almost finished my physics and electrical engineering degrees; I can't think of a better way to spend the remainder of my time at State than pursuing an interdisciplinary degree capturing the whole of what I want to learn.

Artificial and Human Cognition: Learning Outcomes

1) I will be able to explain human cognition on both organizational and anatomical levels.

Brain Signal Analysis

• BME 512: Biological Signal Processing

This will bridge the gap between my abstract understanding of signal processing math and the object of my study: biological signals (and, more specifically, brain signals). The professor will allow me to study the modeling of brain signals for my course project, allowing me to acquaint myself before taking a stronger stab for my capstone.

• ENG 210: Introduction to Language and Linguistics

Linguistics is one of the most important areas of cognitive science, as it studies one of the most compelling, powerful, and unique elements of human cognition: language. This is also, concordantly, one of the most important areas of study in *artificial* cognition, and thus in my major.

Brain Function

• PHI 425: Introduction to Cognitive Science

Cognitive science sits at the core of my self-designed major; this may be the most representative introductory course I'll take, introducing me to the high-level cognitive functions of the human brain and the broad categories (linguistic, imagery, etc.) into which they fall.

• PSY 420: Cognitive Processes

This course is, in essence, bipartite with PHI 425: similar in some areas, unique in others. It, too, will deepen my understanding of the brain on a cognitive-functional level, but with more attention paid to such faculties as memory, reasoning, and problem-solving.

• PSY 430: Biological Psychology

This course bridges the gap between the higher-level operations of the brain and the lower-level anatomical details of neuroscience. I will take it after cognitive science, but before a more traditional neuroscience course, to achieve a smooth transition between regimes.

Brain Anatomy

• BIO 488: Introduction to Neuroscience

The brain is, among other things, a physical organ. Neuroscience offers a level of understanding similar to that of ECE 505: the physical, electrical, and broadly anatomical context. This course will be my most rigorous introduction to the brain as an organ.

2) I will be able to analyze and apply modern principles of artificial intelligence.

- CSC 411: Introduction to Artificial Intelligence

This course will provide an overview of many high-level concepts in artificial intelligence, including search, knowledge representation, logic, planning, and expert systems. These techniques are (for the most part) not explored in deep learning; this course provides insight into a different paradigm of artificial intelligence.

3) I will be able to make ethical decisions pertaining to the integration of human and artificial cognitions.

Biomedical Ethics

- PHI 325: Biomedical Ethics

All of the engineering work I do in the future should be ethically framed. Biomedical ethics will help me chart an ethical path through these technologies, determining how best to develop them.