This form is to be used when proposing a new CAS or GRS course.

This form should be submitted to Senior Academic Administrator Peter Law (617-353-7243) as a PDF file to pgl@bu.edu. For further information or assistance, contact Associate Dean Susan Jackson (617-353-2410; sjackson@bu.edu) about CAS courses or Associate Dean Jeffrey Hughes (617-353-2690; hughes@bu.edu) about GRS courses.

DEPARTMENT OR PROGRAM: Biology   DATE SUBMITTED: 2/6/2017

COURSE NUMBER: CAS BI 598 /CAS NE 598

COURSE TITLE: Neural Circuits

INSTRUCTOR(S): Alberto Cruz-Martín

TO BE FIRST OFFERED: Sem./Year: _Fall___ /__2017__

SHORT TITLE: The “short title” appears in the course inventory, on the Link University Class Schedule, and on student transcripts and must be 15 characters maximum including spaces. It should be as clear as possible.

COURSE DESCRIPTION: This is the description that appears in the CAS and/or GRS Bulletin and The Link. It is the first guide that students have as to what the course is about. The description can contain no more than 40 words.

This course reviews modern techniques and toolsets that are capable of dissecting neural circuits, which are critical for understanding how coordinated patterns of neural activity lead to complex behavior. Recent literature on information processing, guided behavior and cognition is discussed.

PREREQUISITES: Indicate “None” or list all elements of the prerequisites, clearly indicating “AND” or “OR” where appropriate. Here are three examples: “Junior standing or CAS ZN300 or consent of instructor”; “CAS ZN108 and CAS ZN203 and CAS PQ206; or consent of instructor”; “For SED students only.”

1. State the prerequisites: BI325 or NE203 and PY106

2. Explain the need for these prerequisites: In order to understand this class the students need to have a general background in physics, chemistry and biology. In addition, they need to have a basic neuroscience foundation.

CREDITS: (check one)

☐ Half course: 2 credits
☐ Variable: Please describe.
☒ Full course: 4 credits
☐ Other: Please describe.
Provide a rationale for this number of credits, bearing in mind that for a CAS or GRS course to carry 4 credits, 1) it must normally be scheduled to meet at least 150 minutes/week, AND 2) combined instruction and assignments, as detailed in the attached course syllabus, must anticipate at least 12 total hours/week of student effort to achieve course objectives.

My course requires students to attend two weekly lectures/discussions for a total of 4 hours a week. We will also have three hours of office hours available every week. The course does not require a book and relies heavily on discussion of manuscripts/literature. The course is divided into different topics that are centered on understanding specific neural circuits. The first lecture of each topic will be formatted as a lecture given by the instructor; and subsequent lectures will be in the format of a primary group of student presenting and guiding the discussion together with the instructor. Each group will present once or twice during the semester, depending on the total number of students enrolled. In addition, students are required to submit a weekly one-page summary for each of the manuscripts discussed that week and turn in a term paper at the end of the class. The summary should include background on the topic discussed, description of the main question that is addressed in the manuscript, discussion of results and questions on future directions. The instructor will also send a weekly study guide that includes questions. These questions are meant to guide students through the discussions. Student evaluations and grades will be based on weekly summaries, presentations and thoughtful discussion.

DIVISIONAL STUDIES CREDIT: Is this course intended to fulfill Divisional Studies requirements?

☐ Yes. If yes, please indicate which division ______________________ and explain why the course should qualify for Divisional Studies credit. Refer to criteria listed here and specify whether this course is intended for “short” or “expanded” divisional list.

HOW FREQUENTLY WILL THE COURSE BE OFFERED?

☐ Every semester  ☑ Once a year, fall  ☐ Once a year, spring  ☐ Every other year

☐ Other: Explain:

NEED FOR THE COURSE: Explain the need for the course and its intended impact. How will it strengthen your overall curriculum? Will it be required or fulfill a requirement for degrees/majors/minors offered by your department/program or for degrees in other departments/school/colleges? Which students are most likely to be served by this course? How will it contribute to program learning outcomes for those students? If you see the course as being of “possible” or “likely” interest to students in another departments/program, please consult directly with colleagues in that unit. (You must attach appropriate cognate comments using cognate comment form if this course is intended to serve students in specific other programs. See FURTHER INFORMATION below about cognate comment.)

This course is appropriate for those majoring in neuroscience. I have designed this course with two primary purposes. First, this course is intended to delve deeper into neuroscience topics covered in BI325 (synaptic transmission, sensory systems, neural circuits that control appetite, neural circuits that control reward, neural circuits in the context of neuropsychiatric disorders). We will expand on these topics by
discussing modern literature that addresses fundamental questions in those specific fields. These topics are covered under the context of systems neuroscience. I have handpicked the manuscripts to be discussed based on their impact and use of neuroscience modern techniques/tools. In addition, my background and postdoctoral training offers a unique perspective on the literature covered. A second aim of this course will be to provide upper classmen and first year graduate students with the confidence, training and tools needed to critically examine and evaluate modern neuroscience literature; and formulate an informed opinion on the topic discussed. This course should be also beneficial for first year graduate students applying for fellowships such as NRSA or NSF proposals, senior undergraduates planning on attending graduate school and graduate students in other departments that want to expand their knowledge of neuroscience topics. This course would serve as an elective for the following majors: 1) Biology; 2) Biology with a Specialization in Behavioral Biology; 3) Biology with a Specialization in, Cell Biology, Molecular Biology, & Genetics; and 4) Biology with a Specialization in Neurobiology. This course will not serve as a prerequisite for other high level courses.

ENROLLMENT: How many undergraduate and/or graduate students do you expect to enroll in the initial offering of this course?

I am expecting a maximum of 25 students enrolled in my course.

CROSS-LISTING: Is this course to be cross-listed or taught with another course? If so, specify. Chairs/directors of all cross-listing units must co-sign this proposal on the signature line below. The course should be cross-listed in other departments.

This course will be crossed-listed with the undergraduate program in Neuroscience.

OVERLAP:

1. Are there courses in the UIS Course Inventory (CC00) with the same number and/or title as this course?
   X No.
   □ Yes. If yes, any active course(s) with the same number or title as the proposed course will be phased out upon approval of this proposal.
   NOTE: A course number cannot be reused if a different course by that number has been offered in the past five years.

2. Relationship to other courses in your program or others: Is there any significant overlap between this course and others offered by your department/program or by others? (You must attach appropriate cognate comments using cognate comment form if this course might be perceived as overlapping with courses in another department/program. See FURTHER INFORMATION below.)

   BI599 and BI 598 both cover topics related to synaptic transmission, but BI598 covers this topic in the context of systems neuroscience. BI598 has some overlap with BI445, but the BI445 also focuses on understanding neuroscience at a molecular level. BI 502 and BI 598 have some overlap in systems neuroscience topics, but BI 502 takes a more computational approach to understand these.

FACILITIES AND EQUIPMENT: What, if any, are the new or special facilities or equipment needs of the course (e.g., laboratory, library, instructional technology, consumables)? Are currently available facilities, equipment, and other resources adequate for the proposed course? (NOTE: Approval of proposed course does not imply commitment to new resources to support the course on the part of CAS.)
No new facilities or resources needed.

**STAFFING:** How will the staffing of this course, in terms of faculty and, where relevant, teaching fellows, affect staffing support for other courses? For example, are there other courses that will not be taught as often as now? Is the staffing of this course the result of recent or expected expansion of faculty? (NOTE: Approval of proposed course does not imply commitment to new resources to support the course on the part of CAS.)

I don't foresee my course affecting the Department's staffing. This course does not require TFS.

**BUDGET AND COST:** What, if any, are the other new budgetary needs or implications related to the start-up or continued offering of this course? If start-up or continuation of the course will entail costs not already discussed, identify them and how you expect to cover them. (NOTE: Approval of proposed course does not imply commitment to new resources to support the course on the part of CAS.)

This course does not require any new budgetary needs.

**EXTERNAL PROGRAMS:** If this course is being offered at an external program/campus, please provide a brief description of that program and attach a CV for the proposed instructor.

N/A

**FURTHER INFORMATION THAT MUST BE ATTACHED IN ORDER FOR THIS PROPOSAL TO BE CONSIDERED:**

- A complete week-by-week SYLLABUS with student learning objectives, readings, and assignments that reflects the specifications of the course described in this proposal; that is, appropriate level, credits, etc. (See guidelines on "Writing a Syllabus" on the Center for Excellence & Innovation in Teaching website.) Be sure that syllabus includes your expectations for academic honesty, with URL for pertinent undergraduate or GRS academic conduct code(s).

- Cognate comment from chairs or directors of relevant departments and/or programs. Use the form here under “Curriculum Review & Modification.” You can consult with Susan Jackson (CAS) or Jeffrey Hughes (GRS) to determine which departments or programs inside and outside of CAS would be appropriate.

**DEPARTMENT CONTACT NAME AND POSITION:**

**DEPARTMENT CONTACT EMAIL AND PHONE:**

**DEPARTMENT APPROVAL:**

[Signature]

Department Chair

[Date]

[Other Department Chair(s) (for cross-listed courses)]

[Signature]

[Date]
CAS/GRS CURRICULUM COMMITTEE APPROVAL:

☐ Approved  Date: ______________________
☐ Tabled    Date: ______________________
☐ Not Approved  Date: ______________________

Divisional Studies Credit:
☐ Endorsed
  ☐ HU
  ☐ MCS
  ☐ NS
  ☐ SS
☐ Not endorsed

______________________________________________________________
Curriculum Committee Chair Signature and Date
Comments:

PROVISIONAL APPROVAL REQUESTED for Semester/Year ______________________

______________________________________________________________
Dean of Arts & Sciences Signature and Date
Comments:

CAS FACULTY:  Faculty Meeting Date: ______________________ ☐ Approved  ☐ Not Approved

______________________________________________________________
Curriculum Administrator Signature and Date
Comments:
Course Description: A major goal of neuroscience research is to understand how the coordinated patterns of neural activity lead to complex behavior. The brain accomplishes this feat by combining different cell types and wiring them to create neural circuits that have the ability to process information in a variety of ways. Although, the inherent complexity of neural circuits has been difficult to explore, a recent flurry of parallel technological advancements promises to shed light into the contribution of specific cell types and circuits in information processing and behavior. This course will use current research articles to review the new toolsets that are being developed to dissect neural circuits, such as optogenetic and pharmacogenetic approaches, in vivo measurement strategies with genetically encoded calcium indicators (GECIs), viral tracing approaches to label and to manipulate neural activity and multiple mouse transgenic intersectional strategies. In addition, the course will rely heavily on discussion of recent literature that combines these approaches to understand information processing, guided behavior and cognition.

Student Presentation and Discussion: Presentations are held in the Life Science & Engineering Building (LSEB), 4th floor conference room. The schedule for the presentation and the reading assignments is attached to this document. Each student presentation has an assigned reading from the scientific literature, which provides the foundation for presentation and discussion. For the day of presentation/discussion students are expected to read the assigned primary paper and background material and/or secondary literature. A group of students will be chosen to present the primary paper for the day. As part of the presentation the students are expected to provide a few slides on concepts and background information (supplemental papers and videos in Dropbox) that are important for the discussion. The goal of the discussion series and associated readings is to provide you with (1) a more in depth view of major concepts in modern techniques used to dissect neural circuits and (2) to understand how the cellular components of the brain are organized into neural circuits that process information, guide behavior and give rise to cognitive function. Transferable skills that you will develop are i) extracting the main points from scientific papers, ii) critiquing of scientific papers, iii) oral communication of ideas, via participation in discussion, and iv) presentations.

Materials: Readings from the primary scientific literature will be made available on Dropbox (also supplemental material for each week).

Prerequisites: BI325 or NE203 and PY106 or consent of instructor

Course policies: Grading: The discussions will be graded based on reflective participation (5 point scale) and a weekly summary of the paper to be discussed (10%). Taken together, the discussions will account for 20% of the final grade. Students will also be graded on presentations of the primary paper (40%). The instructor will assign students with specific presentations on the first day of class. Each group will have more than two weeks to prepare for the presentation. Students may present more than once during the semester. Lastly, students will be grade on a term paper (30%). Students will need to write a mini review on an assigned topic. This mini review will address the importance of the topic in an introduction and then discuss 4-5 high impact papers that have contributed to a better understanding of this topic. The term paper should also discuss concluding remarks and future directions.
**Attendance:** Non-attendance is not penalized directly. However, you cannot participate in a discussion if you are not there. Discussing difficult concepts and ideas with your peers will give you a greater understanding of the concepts than can be gathered from books alone.

**Make-ups and late work:** There will be no opportunities for make-ups unless you have a valid university excuse.

**Workload:** This is a 4 credit course, so you should anticipate spending a minimum of 8 hours per week outside of class time.

**Conduct:** All undergraduate students and graduate students are expected to know and understand the provisions of the CAS Academic Conduct Code (http://www.bu.edu/academics/cas/policies/academic-conduct/). Cases of suspected academic misconduct will be referred to the Dean’s Office. All work judged by the Dean to have been tainted by misconduct will be assigned an “F”.

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Class Format</th>
<th>Topics</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Tue 1-Sep</td>
<td>Intro to neural circuits I</td>
<td>1</td>
<td>Syllabus, notes: intro to neural circuits, membrane at rest, synapses</td>
</tr>
<tr>
<td>2</td>
<td>Tue 7-Sep</td>
<td>Intro to neural circuits II</td>
<td>2</td>
<td>Discussion of paper and techniques – Fast synaptic transmission, synapses, synaptic arrangements</td>
</tr>
<tr>
<td>3</td>
<td>Tue 14-Sep</td>
<td>Synaptic transmission I</td>
<td>3</td>
<td>Lecture plus discussion of paper – Synapses, synaptic arrangements, neurotransmitter systems</td>
</tr>
<tr>
<td>4</td>
<td>Tue 21-Sep</td>
<td>Synaptic transmission II</td>
<td>4</td>
<td>Group discussions – Organization and development of direction-selective circuits in the retina, inhibitory circuits</td>
</tr>
<tr>
<td>5</td>
<td>Tue 28-Sep</td>
<td>Molecular and synaptic mechanism of plasticity</td>
<td>5</td>
<td>Lecture plus discussion of paper – Molecular and synaptic mechanisms of learning, LTP, LTD and learning</td>
</tr>
<tr>
<td>6</td>
<td>Tue 4-Oct</td>
<td>Molecular and Synaptic mechanism of plasticity</td>
<td>6</td>
<td>Discussion of paper and techniques – Structural plasticity, and plasticity using glutamate uncaging</td>
</tr>
<tr>
<td>7</td>
<td>Tue 11-Oct</td>
<td>Activity-dependent synaptic rearrangements</td>
<td>7</td>
<td>Lecture plus discussion of paper – Wiring of the metaplexionic synapse, neural circuit plasticity and rewiring of the brain</td>
</tr>
<tr>
<td>8</td>
<td>Tue 18-Oct</td>
<td>Activity-dependent synaptic rearrangements</td>
<td>8</td>
<td>Group presentations – Wiring of the metaplexionic synapse, neural circuit plasticity and rewiring of the brain</td>
</tr>
<tr>
<td>9</td>
<td>Tue 25-Oct</td>
<td>Introduction to cortical sensory processing I</td>
<td>9</td>
<td>Lecture plus discussion of paper – Receptive fields, visual system organization, basic architecture cortex, calcium imaging</td>
</tr>
<tr>
<td>10</td>
<td>Tue 30-Oct</td>
<td>Introduction to cortical sensory processing II</td>
<td>10</td>
<td>Group presentations – Using calcium imaging to study cortical sensory processing</td>
</tr>
</tbody>
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<table>
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<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Notes</th>
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<tbody>
<tr>
<td>10-20</td>
<td>Last Day to Add Standard Courses</td>
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</tr>
<tr>
<td>11</td>
<td>Tue 13-Oct</td>
<td>Circuit and Synaptic Mechanisms Underlying Experience-Dependent Cortical Plasticity I</td>
<td>Lecture plus discussion of paper – Ocular dominance, sensory deprivation and cortical circuits</td>
</tr>
<tr>
<td>12</td>
<td>Thu 13-Oct</td>
<td>Circuit and Synaptic Mechanisms Underlying Experience-Dependent Cortical Plasticity II</td>
<td>Presentation – Learning and in vivo plasticity, visual cortex</td>
</tr>
<tr>
<td>13</td>
<td>Tue 19-Oct</td>
<td>Circuit and Synaptic Mechanisms Underlying Experience-Dependent Cortical Plasticity III</td>
<td>Group presentation and technique discussion – Learning and in vivo plasticity, visual cortex</td>
</tr>
<tr>
<td>14</td>
<td>Tue 1-Oct</td>
<td>Circuit and Synaptic Mechanisms Underlying Experience-Dependent Cortical Plasticity IV</td>
<td>Group presentations – Learning and in vivo plasticity, motor cortex</td>
</tr>
<tr>
<td>15</td>
<td>Tue 8-Oct</td>
<td>Role of specific cortical cell types in sensory processing and plasticity I</td>
<td>Lecture plus discussion of paper – Interneurons, function in vivo imaging, plasticity of cortical cell types, parvalbumin</td>
</tr>
<tr>
<td>16</td>
<td>Tue 15-Oct</td>
<td>Role of specific cortical cell types in sensory processing and plasticity II</td>
<td>Group presentation and technique discussion – Interneurons, in vivo imaging, interneuron control of cortical states, somatostatin</td>
</tr>
<tr>
<td>17</td>
<td>Tue 22-Oct</td>
<td>Role of specific cortical cell types in motor plasticity I</td>
<td>Group presentations – Interneurons, in vivo imaging, interneuron control of cortical states, VIP</td>
</tr>
<tr>
<td>18</td>
<td>Tue 29-Oct</td>
<td>Role of specific cortical cell types in motor plasticity II</td>
<td>Group presentations – Regulation of hunger state and overeating disorders</td>
</tr>
<tr>
<td>19</td>
<td>Thu 3-Nov</td>
<td>Using the Allen Brain Atlas and Genest websites to study neural circuits</td>
<td>Lecture and discussion</td>
</tr>
<tr>
<td>20</td>
<td>Thu 9-Nov</td>
<td>Neural circuits controlling appetite I</td>
<td>Lecture and discussion of techniques – Regulation of hunger state and overeating disorders</td>
</tr>
<tr>
<td>21</td>
<td>Thu 16-Nov</td>
<td>Neural circuits controlling appetite II</td>
<td>Group presentations – Regulation of hunger state and overeating disorders</td>
</tr>
<tr>
<td>22</td>
<td>Thu 23-Nov</td>
<td>Neural circuits controlling appetite III</td>
<td>Group presentations – Regulation of hunger state and overeating disorders</td>
</tr>
<tr>
<td>23</td>
<td>Thu 30-Nov</td>
<td>Thanksgiving Access (Nov 22-26)</td>
<td>Last Day to Drop Standard Courses (with a &quot;W&quot; grade)</td>
</tr>
<tr>
<td>24</td>
<td>Tue 1-Dec</td>
<td>Neural circuits controlling reward and aversion I</td>
<td>Group presentations – YTA circuits that generate reward and aversion</td>
</tr>
<tr>
<td>25</td>
<td>Thu 3-Dec</td>
<td>Neural circuits controlling reward and aversion II</td>
<td>Group presentation and technique discussion – YTA and Ca2+ release in response to aversive stimuli</td>
</tr>
<tr>
<td>26</td>
<td>Tue 8-Dec</td>
<td>Neural circuits controlling reward and aversion III</td>
<td>Group presentations – Inhibitory tone to AgRP neurons that control feeding behavior</td>
</tr>
<tr>
<td>27</td>
<td>Thu 15-Dec</td>
<td>Neural circuits controlling reward and aversion IV</td>
<td>Group presentations – Using optogenetics and pharmacogenetic approaches to model neuropsychiatric disorders</td>
</tr>
<tr>
<td>28</td>
<td>Tue 22-Dec</td>
<td>Term paper discussion</td>
<td>2 Term paper discussion</td>
</tr>
<tr>
<td>29</td>
<td>Thu 27-Dec</td>
<td>Final exams End</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- Make-ups and late work: There will be no opportunities for make-ups unless you have a valid university excuse.
- Workload: This is a 4 credit course, so you should anticipate spending a minimum of 8 hours per week outside of class time.
- Conduct: All undergraduate students and graduate students are expected to know and understand the provisions of the CAS Academic Conduct Code (http://www.bu.edu/academics/cas/policies/academic-conduct/). Cases of suspected academic misconduct will be referred to the Dean’s Office. All work judged by the Dean to have been tainted by misconduct will be assigned an “F.”