

B.Eng. Electrical Engineering Photonics and Optoelectronics Stream Manual Draft v4.0

Department of Electronics, Carleton University

Working draft for discussion (v4.0, April 9, 2026)

This v4.0 draft reflects the official degree wording Bachelor of Engineering: Electrical Engineering Stream A- Photonics and Optoelectronics as a named stream within Carleton's existing CEAB-accredited Electrical Engineering degree. It focuses on a modest curricular delta, controlled use of existing elective space, and implementation considerations within the existing degree framework.

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PART 1: Stream Manual

1 Executive Summary

This v4.0 draft uses the official degree name **Bachelor of Engineering: Electrical Engineering Stream A- Photonics and Optoelectronics** as a named stream within Carleton's existing CEAB-accredited B.Eng. Electrical Engineering degree. It does not propose a separate accredited degree. The model is intentionally modest. It uses a small, auditable stream delta, preserves the existing degree structure, and combines a fixed stream core with a controlled upper-year elective basket and a stream-specific Year 4 capstone.

The curricular model is as follows. The only required-course replacement in the degree tree is ELEC 2PH0 *Introduction to Photonics*, which would replace ELEC 2602 for students in the stream pathway. The fixed upper-year stream core consists of ELEC 4CP0 *Co-Packaged Optics*, ELEC 4SPD *Silicon Photonics Design*, and ELEC 4909, the *Photonics and Optoelectronics Capstone Project*, which replaces ELEC 4907 one-for-one in the existing Year 4 capstone slot for stream students. Students also complete 1.0 credit of approved upper-year stream electives using the remaining two Year 4 engineering elective slots: 0.5 credit from Basket A, *Photonics Devices, Materials, and Optical Systems*, and 0.5 credit from Basket B, *Optoelectronic Circuits, Interfaces, and Integration*.

The stream pathway remains a 21.0-credit pathway within the existing B.Eng. Electrical Engineering degree. ELEC 2995 remains a required 0.0-credit, two-term requirement, consistent with the base degree. The stream does not add net credits. ELEC 2PH0 replaces ELEC 2602 in Year 2 Winter, ELEC 4909 replaces ELEC 4907 in the existing Year 4 capstone slot for stream students, ELEC 4CP0 and ELEC 4SPD occupy two of the four existing Year 4 engineering elective slots, and the remaining two Year 4 engineering elective slots are occupied by approved Basket A and Basket B stream-elective selections.

This stream remains under the umbrella of the existing CEAB-accredited B.Eng. Electrical Engineering degree. It is not a separate degree and would not seek separate accreditation. Carleton would ensure that students following the stream pathway continue to satisfy the requirements of the accredited B.Eng. Electrical Engineering degree, including AU compliance by pathway. The Year 2 replacement course would be AU-matched to the course it replaces. Significant design experience would remain under Carleton's academic control and responsibility within the existing degree structure.

Summer experience may complement the stream pathway, but it is not presented here as a separate curricular structure. CO-OP work terms are 4 months in duration and occur during the summer term. Participation follows normal co-op and employer processes.

2 Purpose and Guiding Constraints

This document is written as a working draft for a stream within the existing B.Eng. Electrical Engineering degree. It remains within the existing degree framework and does not propose a broader restructuring of the Electrical Engineering curriculum.

The draft is guided by four constraints:

1. The stream pathway should remain clearly within the existing CEAB-accredited B.Eng. Electrical Engineering degree.
2. The curricular change should be limited to a small, auditable stream delta.
3. Upper-year stream depth should rely as much as possible on existing elective space and a narrow, auditable approved stream-elective structure.
4. Implementation assumptions should be stated cautiously and only to the extent needed to show that the stream is manageable within normal academic planning processes.

3 Rationale and Positioning

3.1 Why a Stream Within the Existing Degree

Photonics, optoelectronics, optical communications, and related optical-link technologies are areas of clear technical relevance for Electrical Engineering students. The proposed stream pathway provides a coherent way for interested students to develop depth in these areas while retaining the breadth of the existing B.Eng. Electrical Engineering degree.

The stream framing is also the simpler governance model. Because the pathway remains within the existing CEAB-accredited degree, the proposal can be considered as a stream-specific pattern of course requirements within the established degree structure. The question is therefore whether the stream pathway is academically coherent, administratively manageable, and compatible with the requirements of the existing degree.

3.2 Preferred Curricular Model

The preferred model is a single, modest stream structure built from a small, auditable stream delta, a fixed photonics-and-optoelectronics core, a controlled approved stream-elective basket, and a stream-specific Year 4 capstone replacement. Only one second-year course is replaced in the required program tree. In Year 4, ELEC 4909 replaces ELEC 4907 one-for-one in the existing 2-term, 1.0-credit capstone slot for stream students, ELEC 4CP0 and ELEC 4SPD occupy two of the four existing engineering elective slots already present in the base EE degree, and students complete 1.0 credit of approved upper-year stream electives consisting

of 0.5 credit from Basket A and 0.5 credit from Basket B. The pathway therefore remains 21.0 credits and does not add net credits.

4 Stream Overview

For formal purposes, the official degree name used in this draft is **Bachelor of Engineering: Electrical Engineering Stream A- Photonics and Optoelectronics**. For readability, the shorter form **Photonics and Optoelectronics Stream** is also used.

4.1 Educational Intent

The stream pathway is intended to give students a coherent sequence in:

- photonics and optoelectronic device fundamentals,
- co-packaged optics and associated packaging and test constraints,
- silicon photonics design methods,
- optical systems and communications considerations, and
- optoelectronic circuits, interfaces, and implementation questions.

The stream is intentionally structured as a fixed photonics-and-optoelectronics core plus a controlled upper-year elective basket. This preserves a common stream identity while allowing students to develop somewhat different emphases within the stream, for example toward devices and optical systems on the one hand, or optoelectronic circuits and integration on the other.

The Basket B requirement is deliberate: because the stream is titled Photonics and Optoelectronics, the pathway should include a visible electronics and implementation dimension, not only optical devices or optical communications.

The compulsory core of the stream already spans both photonics and optoelectronics. **ELEC 2PH0** introduces photonic and optoelectronic fundamentals, **ELEC 4CP0** addresses the electrical-photonic interface in packaging and system implementation, **ELEC 4SPD** develops photonic design and integration methods, and **ELEC 4909** provides a stream-specific capstone in photonics and optoelectronics. The approved upper-year stream-elective baskets therefore function as controlled mechanisms for additional depth and emphasis, not as the sole source of the stream's photonics-and-optoelectronics identity.

The pathway remains anchored in the full Electrical Engineering degree. Students following the stream continue to complete the standard Electrical Engineering foundation and the established degree-level design experience.

4.2 Learning Outcomes Alignment

The underlying program-level learning outcomes of the accredited B.Eng. Electrical Engineering degree remain unchanged. The stream introduces a focused curricular emphasis in photonics and optoelectronics within that existing degree-level framework through a fixed core of ELEC 2PH0, ELEC 4CP0, ELEC 4SPD, and ELEC 4909, together with 1.0 credit selected from approved upper-year stream-elective baskets. In that sense, the stream sharpens curricular emphasis rather than redefining the core learning goals of the Electrical Engineering degree.

Because the compulsory core already spans both sides of the stream title, the approved basket structure is used to provide controlled additional depth and implementation emphasis rather than to create multiple formal substreams.

5 Concrete Curriculum Structure

5.1 Baseline Degree Structure

The stream pathway assumes that the existing B.Eng. Electrical Engineering structure remains largely intact. The intent is not to redesign the EE spine, but to define a modest stream-specific pattern inside it.

5.2 Modest Stream Delta

The formal stream structure consists of the following fixed core plus one controlled upper-year elective requirement:

1. ELEC 2PH0 Introduction to Photonics, which replaces ELEC 2602 for students in the stream pathway.
2. ELEC 4CP0 Co-Packaged Optics, accommodated within one of the four existing Year 4 engineering elective slots.
3. ELEC 4SPD Silicon Photonics Design, accommodated within one of the four existing Year 4 engineering elective slots.
4. ELEC 4909 Photonics and Optoelectronics Capstone Project, which replaces ELEC 4907 one-for-one in the existing Year 4 capstone slot for students in the stream pathway.
5. 1.0 credit of approved upper-year stream electives, consisting of 0.5 credit from Basket A and 0.5 credit from Basket B, using the remaining two Year 4 engineering elective slots.

The stream-specific additions are limited to these three new taught courses plus the capstone replacement ELEC 4909, together with 1.0 credit selected from approved stream-elective

baskets. ELEC 4CP0 and ELEC 4SPD each occupy one of the four existing Year 4 engineering elective slots, and the approved Basket A and Basket B selections occupy the remaining two Year 4 engineering elective slots.

Table 1: Stream structure

Course	Role in stream pathway	Location in the existing degree structure
ELEC 2PH0	Stream-specific required-course replacement	Replaces ELEC 2602 in Year 2 Winter for stream students
ELEC 4CP0	New stream course	Occupies one of the four existing Year 4 engineering elective slots
ELEC 4SPD	New stream course	Occupies one of the four existing Year 4 engineering elective slots
ELEC 4909	Stream-specific capstone replacement	Replaces ELEC 4907 one-for-one in the existing Year 4 capstone slot for stream students
Basket A selection	Approved stream elective (0.5 credit)	Occupies one of the remaining Year 4 engineering elective slots
Basket B selection	Approved stream elective (0.5 credit)	Occupies one of the remaining Year 4 engineering elective slots

This structure keeps the stream pathway compact, preserves a 21.0-credit total, and does not require a larger conversion of the existing Electrical Engineering curriculum. It also keeps the upper-year flexibility narrow and auditable because the basket choices are defined in the rules rather than open-ended.

5.3 Second-Year Required-Course Replacement

For students in the stream pathway, ELEC 2602 **Electric Machines and Power** is replaced by ELEC 2PH0 **Introduction to Photonics**. This is the only required-course replacement in the model.

The purpose of this replacement is to provide early stream-specific preparation for later work in photonics, optical communications, and silicon photonics. In accreditation terms, this course would be AU-matched to the required course it replaces.

5.4 Upper-Year Stream Courses in Existing Elective Space

The stream pathway uses two new upper-year courses within the four existing Year 4 engineering elective slots already present in the base degree. ELEC 4CP0 occupies one of those slots, and ELEC 4SPD occupies another.

ELEC 4CP0 **Co-Packaged Optics** addresses architectures, packaging constraints, thermal and mechanical considerations, and test implications relevant to optical I/O and related systems.

ELEC 4SPD Silicon Photonics Design addresses photonic integrated circuit design methods, circuit composition, simulation and verification, layout constraints, and design-for-manufacture considerations.

Because these courses are accommodated within those existing Year 4 engineering elective slots, they do not create additional required-course substitutions beyond the Year 2 stream-specific replacement. The required **ELEC 4CP0** and **ELEC 4SPD** core courses occupy two of the four existing Year 4 engineering elective slots, and the approved Basket A and Basket B selections occupy the remaining two Year 4 engineering elective slots. The pathway therefore does not create net additional credits.

5.5 Approved Stream-Elective Baskets

Depth beyond the fixed core stream-specific additions is provided through approved stream-elective baskets. Students in the stream pathway must complete 1.0 credit of approved upper-year stream electives, consisting of 0.5 credit from Basket A and 0.5 credit from Basket B.

The compulsory core already spans both photonics and optoelectronics, so the approved baskets are used as controlled mechanisms for additional depth and emphasis rather than as the sole source of the stream's identity. The baskets are intentionally narrow enough that the pathway remains visibly Photonics and Optoelectronics rather than becoming a diffuse menu of EE electives.

Basket A: Photonics Devices, Materials, and Optical Systems. Students complete 0.5 credit from one of:

- **ELEC 4700 The Physics and Modeling of Advanced Devices and Technologies**
- **ELEC 4702 Fiber Optic Communications**
- **ELEC 4704 Nanoscale Technology and Devices**
- **ELEC 4705 Electronic Materials, Devices and Transmission Media**
- **ELEC 4906 Special Topics**, only where the topic has been explicitly approved by the Associate Chair (Undergraduate) as aligned with photonics, optical devices, quantum photonics, or related optical systems

Basket B: Optoelectronic Circuits, Interfaces, and Integration. Students complete 0.5 credit from one of:

- **ELEC 4706 High-Speed Electronics: Circuits and Systems**
- **ELEC 4707 Analog Integrated Electronics**

- **ELEC 4609 Integrated Circuit Design and Fabrication**
- **ELEC 4906 Special Topics**, only where the topic has been explicitly approved by the Associate Chair (Undergraduate) as aligned with optical transceivers, TIAs, laser drivers, mixed-signal photonics interfaces, or related implementation topics

Not every listed elective would necessarily be offered every year, and **ELEC 4906** is not automatically valid for the stream. Where **ELEC 4906** is used to satisfy a stream-elective basket requirement, the topic must be explicitly approved by the Associate Chair (Undergraduate) as aligned with the Photonics and Optoelectronics Stream, and that approval must be recorded through normal departmental advising and degree-audit processes.

5.6 Project Alignment

The stream-specific project identity is carried by **ELEC 4909 Photonics and Optoelectronics Capstone Project**, which replaces **ELEC 4907** one-for-one in the existing two-term, 1.0-credit Year 4 capstone slot for students in the stream pathway. **ELEC 4909** is photonics- and optoelectronics-oriented and provides the pathway's distinct capstone design experience while remaining straightforward to administer within existing departmental project approval and oversight processes.

5.7 Stream Rule Set

The stream rule set is intended to be simple and auditable. Students in the stream pathway must complete:

1. **ELEC 2PH0** in place of **ELEC 2602**;
2. **ELEC 4CP0** and **ELEC 4SPD**, each within one of the four existing Year 4 engineering elective slots and together within two of those four slots;
3. 1.0 credit of approved upper-year stream electives, consisting of 0.5 credit from Basket A and 0.5 credit from Basket B; and
4. **ELEC 4909** in place of **ELEC 4907**.

The stream remains a 21.0-credit pathway, and the approved Basket A and Basket B choices occupy the remaining two Year 4 engineering elective slots.

Sequencing and Access to Stream Courses. **ELEC 2PH0** is intended to serve as the foundational Year 2 course for the new stream-specific fourth-year courses. In that sense, **ELEC 4CP0**, **ELEC 4SPD**, and **ELEC 4909** are intended to function as part of a sequenced Photonics and Optoelectronics stream pathway rather than as general Electrical Engineering electives. By contrast, the approved Basket A and Basket B options are existing EE electives or **ELEC**

4906 topics approved by the Associate Chair (Undergraduate) for the relevant basket, and may still be taken by non-stream students where ordinary degree rules, prerequisites, term offerings, and capacity permit. Within the stream, however, those basket choices are used in a specific and auditable way to satisfy the required upper-year stream-elective structure. Detailed prerequisite chains would be finalized through normal course-approval processes.

After ELEC 4CP0, ELEC 4SPD, and the two approved basket selections are assigned to the four existing Year 4 engineering elective slots, the remaining non-stream flexible space in Year 4 is the existing complementary studies slot and the existing basic science/engineering slot. Any additional stream-relevant choices beyond the required pathway would occur only through normal advising where permitted.

6 Accreditation and Governance Considerations

The official credential wording is **Bachelor of Engineering: Electrical Engineering Stream A- Photonics and Optoelectronics**. Accordingly, the stream is treated as a named stream within the existing CEAB-accredited Electrical Engineering degree, rather than as a separate accredited degree.

The stream pathway remains a 21.0-credit pathway within the existing B.Eng. Electrical Engineering degree. ECOR 2995 remains a required 0.0-credit, two-term requirement, consistent with the base degree. The stream does not add net credits. ELEC 2PH0 replaces ELEC 2602 in Year 2 Winter, ELEC 4909 replaces ELEC 4907 in the existing Year 4 capstone slot for stream students, ELEC 4CP0 and ELEC 4SPD occupy two of the four existing Year 4 engineering elective slots, and the remaining two Year 4 engineering elective slots are occupied by approved Basket A and Basket B stream-elective selections.

The main accreditation considerations are limited and direct:

- students following the stream pathway would continue to satisfy the requirements of the accredited B.Eng. Electrical Engineering degree;
- AU compliance would be reviewed by pathway;
- the only required-course replacement is ELEC 2PH0, and that replacement would be AU-matched to the course it replaces; and
- ELEC 4909 replaces ELEC 4907 one-for-one in the existing Year 4 capstone slot, ELEC 4CP0 and ELEC 4SPD occupy two of the four existing Year 4 engineering elective slots, the approved Basket A and Basket B selections occupy the remaining two Year 4 engineering elective slots in the degree tree, and ECOR 2995 remains the same required 0.0-credit, two-term requirement as in the base degree.

Because the official credential wording includes the stream designation, Carleton would document, for CEAB purposes, that the pathway contains a significant amount of distinct and

readily identifiable engineering science and/or engineering design content, at least equivalent to one semester of program content. In this revised model, the stream-specific content is carried by a fixed core of ELEC 2PH0, ELEC 4CP0, ELEC 4SPD, and ELEC 4909, together with 1.0 credit selected from approved Photonics and Optoelectronics stream-elective baskets, for a total of 3.5 credits of readily identifiable stream-specific engineering science and/or engineering design content. The content remains auditable because the basket structure is defined in the stream rules, and Carleton would continue to consult the CEAB Secretariat regarding naming and implementation.

ELEC 4909 will be developed and administered as the stream-specific replacement for the existing Year 4 capstone slot, preserving the role of the capstone design requirement within the degree structure and maintaining its academic and accreditation integrity under normal departmental oversight.

Significant design experience remains under Carleton's control and academic responsibility within the existing degree structure through the Year 4 capstone structure, and associated departmental oversight.

6.1 Inter-Unit Planning Implications

The stream-specific curricular changes are primarily housed within Electronics and within the existing EE degree structure. However, any material increase in Electrical Engineering enrolment attributable to the stream would have downstream implications for shared teaching and support provided by other academic units contributing to the EE curriculum. Those effects may include pressure on shared courses, laboratories, scheduling, advising, and administrative support, and would need to be monitored and addressed through normal enrolment planning, timetabling, resource-allocation, and governance processes.

7 Summer Co-op Context

The stream pathway may be complemented by summer co-op participation. CO-OP work terms are 4 months in duration and occur during the summer term.

The stream envisions summer co-op participation aligned with standard 4-month summer work terms. Participation is subject to normal co-op and employer processes. No separate summer stream requirement is assumed in this draft.

8 Implementation Notes

For implementation purposes, the official degree name is **Bachelor of Engineering: Electrical Engineering Stream A- Photonics and Optoelectronics**, while the curriculum

remains within the existing CEAB-accredited Electrical Engineering degree. The implementation assumptions in this draft are intentionally limited.

1. Course outlines, prerequisites, and scheduling for ELEC 2PH0, ELEC 4CP0, ELEC 4SPD, and ELEC 4909 would need to be finalized through normal academic processes.
2. AU mapping would be completed for the Year 2 stream-specific replacement course.
3. Advising material, degree-audit logic, and calendar language would need to identify the stream pathway clearly, including the fixed core, the required use of the four existing Year 4 engineering elective slots for ELEC 4CP0, ELEC 4SPD, and one approved Basket A plus one approved Basket B selection, the one-for-one replacement of ELEC 4907 by ELEC 4909, and the normal recording of any Basket A or Basket B use of ELEC 4906 after topic-specific approval by the Associate Chair (Undergraduate).
4. Calendar, capstone-administration, and advising processes would need to identify ELEC 4909 as the required stream capstone.
5. Initial delivery would be modest and aligned with available departmental instructional and laboratory capacity, with any incremental needs identified and addressed through normal planning and approval processes.

Initial delivery is intended to be modest and aligned with available instructional and laboratory capacity. At modest scale, the stream can be delivered within the existing degree structure and departmental processes. If the stream materially increases Electrical Engineering enrolment, incremental resource pressures may arise not only within Electronics but also in shared teaching and support across units contributing to the degree, and any such needs would be addressed through normal planning and approval processes.

Implementation of the stream would proceed through Carleton's normal major-modification, calendar, and governance processes, with associated approval materials addressing official naming, resource implications, and related operational details.

9 Concluding Position

The case for this draft is intentionally narrow. It presents a stream pathway within the existing B.Eng. Electrical Engineering degree, built around one required-course replacement, a fixed upper-year stream core, a controlled approved stream-elective basket, and a stream-specific Year 4 capstone replacement. The result is a coherent 21.0-credit stream pathway with no net added credits relative to the base degree, and it remains modest in curricular scope and compatible with the governance framework of the existing degree.

PART 2: Summer Co-op Context and Student Pathway Notes

10 Purpose

This part retains summer and student-pathway material in a restrained background form. It does not create a separate curricular structure or an operational commitment beyond normal co-op and departmental processes.

11 Summer Co-op Pathway

CO-OP work terms are 4 months in duration and occur during the summer term. The stream pathway anticipates that some students may seek summer co-op work that is relevant to photonics, optoelectronics, optical communications, testing, or related areas.

Any such participation remains subject to normal co-op eligibility rules, employer hiring decisions, and available opportunities. In this draft, summer co-op participation is complementary to the stream pathway rather than a separate stream requirement.

12 Illustrative Student Progression

An illustrative progression is:

- Year 1 and Year 2: students complete the standard B.Eng. Electrical Engineering curriculum, with the stream-specific replacement taking effect in Year 2 Winter.
- Year 3: students complete the standard curriculum.
- Year 4: students complete ELEC 4909 in place of ELEC 4907, complete ELEC 4CP0 and ELEC 4SPD, and complete one approved Basket A plus one approved Basket B stream elective within the four existing Year 4 engineering elective slots.

Where students participate in co-op, summer work terms would normally occur during the summer term and follow the standard 4-month work-term pattern.

13 Operational Notes

Student advising for the stream pathway would identify recommended sequencing, prerequisites, and the relationship between the stream pathway and normal co-op participation.

Any employer engagement associated with summer co-op would remain subject to standard university and employer processes. If the stream contributes to material growth in Electrical Engineering enrolment, any downstream effects on shared courses, laboratories, scheduling, advising, or administrative support would be handled through normal planning and governance processes.

Appendices

A Curriculum Outline

This appendix summarizes the stream-specific elements of the curriculum. Except as noted below, students in the stream pathway follow the standard B.Eng. Electrical Engineering curriculum as published.

A.1 Year 2 Winter

ELEC 2PH0: Introduction to Photonics (proposed)

Foundations of photonics for electrical engineers. Optical propagation concepts relevant to guided-wave systems, sources and detectors, modulation, noise and sensitivity, optical power measurement, and introductory fiber and link-budget concepts. Laboratory work emphasizes safe optical handling and characterization of optoelectronic components.

Stream role: replaces ELEC 2602 for students in the stream pathway.

A.2 Year 4 Fall

ELEC 4909: Photonics and Optoelectronics Capstone Project (proposed)

A two-term capstone design project in photonics and optoelectronics. Student teams develop professional-level experience by applying, integrating, and extending previously acquired knowledge in a major design project focused on photonic, optoelectronic, optical-link, optical-packaging, optical-test, silicon-photonics, or related systems. A project proposal, interim report, oral presentations, verification activities, and a comprehensive final report are required.

Stream role: replaces ELEC 4907 one-for-one in the existing Year 4 capstone slot for students in the stream pathway.

Approved Stream Elective (Basket A)

Students complete 0.5 credit from Basket A: ELEC 4700, ELEC 4702, ELEC 4704, ELEC 4705, or ELEC 4906 where the topic has been explicitly approved by the Associate Chair (Undergraduate) as aligned with photonics, optical devices, quantum photonics, or related optical systems.

Stream role: approved upper-year stream elective occupying one of the remaining Year 4 engineering elective slots within the stream pathway.

ELEC 4CP0: Co-Packaged Optics (proposed)

Architectures and engineering constraints for co-packaged optics and related optical I/O. Topics include electrical-photonic partitioning, packaging and assembly constraints, thermal and mechanical considerations, and test and validation strategy.

Stream role: new stream course accommodated within one of the four existing Year 4 engineering elective slots.

A.3 Year 4 Winter

ELEC 4909: Photonics and Optoelectronics Capstone Project (continued)

Continuation of the two-term capstone design project in photonics and optoelectronics.

Stream role: continuation of the required stream capstone that replaces ELEC 4907 in the existing Year 4 capstone slot.

Approved Stream Elective (Basket B)

Students complete 0.5 credit from Basket B: ELEC 4706, ELEC 4707, ELEC 4609, or ELEC 4906 where the topic has been explicitly approved by the Associate Chair (Undergraduate) as aligned with optical transceivers, TIAs, laser drivers, mixed-signal photonics interfaces, or related implementation topics.

Stream role: approved upper-year stream elective occupying one of the remaining Year 4 engineering elective slots within the stream pathway.

ELEC 4SPD: Silicon Photonics Design (proposed)

Silicon photonics design methodology using foundry design flows. Topics include photonic building blocks, circuit composition, simulation and verification, layout constraints, and design-for-manufacture considerations. Students complete a substantial design exercise with documented specifications and verification.

Stream role: new stream course accommodated within one of the four existing Year 4 engineering elective slots.

A.4 Remaining Upper-Year Space

There is no remaining Year 4 engineering elective within the required stream pathway once ELEC 4CP0, ELEC 4SPD, and the approved Basket A and Basket B selections occupy the

four existing Year 4 engineering elective slots. The remaining non-stream flexible space in the published structure is the existing complementary studies slot and the existing basic science/engineering slot. Any additional stream-relevant choices beyond the required pathway would occur only through normal advising where permitted.

B Accreditation Notes for the Stream Pathway

B.1 Purpose

This appendix records the accreditation posture assumed by this draft.

B.2 Core Position

The official credential wording is **Bachelor of Engineering: Electrical Engineering Stream A- Photonics and Optoelectronics**. The stream pathway remains within the existing CEAB-accredited B.Eng. Electrical Engineering degree. It is not a separate degree and would not seek separate accreditation.

B.3 Implications for Pathway Review

The stream pathway is intended to remain compatible with the existing accredited degree on the following basis:

1. Carleton would ensure that students following the stream pathway continue to satisfy the requirements of the accredited B.Eng. Electrical Engineering degree.
2. Only the second-year stream course replaces an existing required course in the degree tree, and the AU mapping for that replacement would be matched appropriately.
3. ELEC 4909 replaces ELEC 4907 one-for-one in the existing Year 4 capstone slot, ELEC 4CP0 and ELEC 4SPD occupy two of the four existing Year 4 engineering elective slots, and the approved Basket A and Basket B selections occupy the remaining two Year 4 engineering elective slots in the degree tree, so the pathway remains 21.0 credits with no net added credits.
4. Significant design experience remains under Carleton's academic control and responsibility within the existing degree structure.

Because the official credential wording includes the stream designation, Carleton would document, for CEAB purposes, that the pathway contains a significant amount of distinct and readily identifiable engineering science and/or engineering design content, at least equivalent to one semester of program content. In this revised model, the stream-specific content is carried by a fixed core of ELEC 2PH0, ELEC 4CP0, ELEC 4SPD, and ELEC 4909, together with 1.0 credit selected from approved Photonics and Optoelectronics stream-elective baskets, for a total of 3.5 credits of readily identifiable stream-specific engineering science and/or engineering design content. Carleton would document the basket structure in the stream description and degree-audit logic, and would continue to consult the CEAB Secretariat regarding naming and implementation.

Because the stream remains within the existing CEAB-accredited B.Eng. Electrical Engineering degree, the relevant accredited credential for licensure purposes remains the undergraduate Electrical Engineering degree.

C Student-Facing Web Copy

Photonics and Optoelectronics Stream

Stream within the B.Eng. Electrical Engineering degree

Overview

The official degree name is **Bachelor of Engineering: Electrical Engineering Stream A- Photonics and Optoelectronics**. This is the official stream name within Carleton's existing B.Eng. Electrical Engineering degree, not a separate standalone degree. The stream pathway remains a 21.0-credit pathway, the same as the base degree. Students follow the standard Electrical Engineering curriculum, ECOR 2995 remains the same required 0.0-credit two-term requirement, and the stream does not add net credits.

Structure

The stream pathway is based on a modest curriculum pattern:

- ELEC 2PH0 in place of ELEC 2602 in Year 2 Winter;
- a fixed upper-year core of ELEC 4CP0 and ELEC 4SPD;
- 1.0 credit of approved upper-year stream electives, consisting of 0.5 credit from Basket A and 0.5 credit from Basket B; and
- ELEC 4909 in place of ELEC 4907 in the existing Year 4 capstone slot.

The compulsory core already spans both photonics and optoelectronics, while the approved upper-year baskets allow additional emphasis without turning the stream into an open-ended menu.

Projects

The stream-specific project identity is carried by ELEC 4909, the *Photonics and Optoelectronics Capstone Project*, which replaces ELEC 4907 in Year 4 for students in the stream pathway.

Summer Terms

CO-OP work terms are 4 months in duration and occur during the summer term. Students may pursue summer co-op opportunities relevant to the stream pathway, subject to normal co-op and employer processes.

Questions

Is this still the accredited Electrical Engineering degree?

Yes. The official degree name is **Bachelor of Engineering: Electrical Engineering Stream A- Photonics and Optoelectronics**, and it remains within the existing CEAB-accredited B.Eng. Electrical Engineering degree.

Is this a separate degree?

No. It is a named stream within the Electrical Engineering degree, not a separate standalone degree.

How do students follow the stream pathway?

Students follow the normal Electrical Engineering curriculum and complete a fixed stream core together with a defined pair of approved upper-year stream-elective baskets. The pathway uses approved upper-year choices rather than an open-ended menu.

D One-Page Student Brochure Text

Photonics and Optoelectronics

Stream within the B.Eng. Electrical Engineering degree

The official degree name is **Bachelor of Engineering: Electrical Engineering Stream A- Photonics and Optoelectronics**. This is the official stream name within Carleton's existing B.Eng. Electrical Engineering degree, not a separate standalone degree. The stream pathway remains a 21.0-credit pathway, the same as the base degree, and does not add net credits. It provides a fixed core plus a defined set of approved upper-year choices for students who want upper-year depth in photonics and optoelectronics.

Pathway Summary

Students in the stream pathway complete:

- ELEC 2PH0 in place of ELEC 2602;
- a fixed upper-year core of ELEC 4CP0 and ELEC 4SPD;
- 1.0 credit of approved upper-year stream electives, consisting of one Basket A choice and one Basket B choice; and
- ELEC 4909 in place of ELEC 4907 in the existing Year 4 capstone slot.

The compulsory core already spans both photonics and optoelectronics, while the approved upper-year baskets allow additional emphasis within a clear and auditable stream structure.

Summer Terms

CO-OP work terms are 4 months in duration and occur during the summer term. Students may pursue relevant summer co-op opportunities through normal co-op and employer processes.

Degree Status

The stream pathway remains within the existing CEAB-accredited B.Eng. Electrical Engineering degree.

E Operational Preconditions and Phased Implementation Plan

E.1 Purpose

This appendix summarizes the minimum operational considerations associated with **Bachelor of Engineering: Electrical Engineering Stream A- Photonics and Optoelectronics**.

E.2 Operating Principles

1. The stream pathway should remain modest in curricular scope.
2. Initial delivery should rely primarily on existing degree structures, existing elective space, and departmental academic processes, at a modest scale aligned with available instructional and laboratory capacity.
3. If the stream materially increases Electrical Engineering enrolment, incremental resource pressures may arise within Electronics and in shared teaching and support across units contributing to the degree; any such needs should be handled through normal planning and approval processes.
4. Advising and public-facing materials should describe the stream pathway accurately and conservatively.

E.3 Launch Readiness Items

Before implementation, the following items would need to be completed:

1. finalized course outlines and scheduling for ELEC 2PH0, ELEC 4CP0, ELEC 4SPD, and ELEC 4909;
2. AU review for the ELEC 2PH0 replacement;
3. stream pathway advising material identifying the fixed upper-year core of ELEC 4CP0 and ELEC 4SPD, the required use of the remaining two Year 4 engineering elective slots for one approved Basket A selection and one approved Basket B selection, the one-for-one replacement of ELEC 4907 by ELEC 4909, and the normal recording of any Basket A or Basket B use of ELEC 4906 after topic-specific approval by the Associate Chair (Undergraduate);
4. calendar and capstone-administration processes identifying ELEC 4909 as the required stream capstone; and

5. confirmation that departmental instructional and laboratory resources are sufficient for the planned initial scale of delivery, together with normal coordination for any shared teaching or support impacts.

E.4 Phased Implementation

Phase 0: Preparation

Complete curricular documentation, scheduling, AU review, and advising material.

Phase 1: Initial delivery

Offer the stream pathway at a modest scale consistent with available instructional and laboratory resources, and review first-cycle delivery experience together with any shared-load implications for contributing units.

Phase 2: Steady state

Continue the stream pathway through normal curriculum review and department planning processes.

E.5 Summer Co-op Notes

Summer co-op participation is treated as complementary to the stream pathway. Any coordination with employers would remain subject to standard co-op and employer processes, available opportunities, and departmental capacity to advise students.

F Laboratory Infrastructure Notes

F.1 Purpose

This appendix records the laboratory assumptions associated with the stream pathway without presenting a detailed capital plan.

F.2 Delivery Approach

Delivery of the stream pathway would rely on departmental laboratory resources and instructional infrastructure appropriate to:

- introductory photonics and optoelectronic instruction and measurement in ELEC 2PH0,
- upper-year instruction related to packaging, test, optical-system, and optoelectronic interface work, and
- software, computing, and implementation support for silicon photonics design and related integration-oriented activities.

F.3 Planning Position

At modest scale, delivery of the stream pathway can proceed within the existing degree structure and departmental processes. Any incremental laboratory, software, safety, technical-support, or shared-support needs would be developed through normal departmental planning and university approval processes. The stream pathway does not depend on a detailed equipment acquisition plan being embedded in the curriculum proposal itself.

G Term-by-Term Course Schedule

This appendix summarizes the stream pathway by term. Except as noted below, the standard B.Eng. Electrical Engineering curriculum applies.

G.1 Year 1

Table 2: Year 1 stream pathway summary

Term	Summary
Fall	Standard B.Eng. Electrical Engineering curriculum
Winter	Standard B.Eng. Electrical Engineering curriculum
Summer	Optional 4-month CO-OP work term, subject to normal co-op and employer processes

G.2 Year 2

Table 3: Year 2 stream pathway summary

Term	Summary
Fall	Standard B.Eng. Electrical Engineering curriculum
Winter	Standard curriculum, except ELEC 2PH0 replaces ELEC 2602 for stream students
Summer	Optional 4-month CO-OP work term, subject to normal co-op and employer processes

G.3 Year 3

Table 4: Year 3 stream pathway summary

Term	Summary
Fall	Standard B.Eng. Electrical Engineering curriculum
Winter	Standard B.Eng. Electrical Engineering curriculum
Summer	Optional 4-month CO-OP work term, subject to normal co-op and employer processes

G.4 Year 4

Table 5: Year 4 stream pathway summary

Term	Summary
Fall	ELEC 4909; approved stream elective (Basket A); ELEC 4CP0; ELEC 4601; SYSC 4505; ECOR 4995; ECOR 2995
Winter	ELEC 4909 continuation; approved stream elective (Basket B); ELEC 4SPD; Comp. Studies; Basic Sci/Eng; ECOR 2995

H Approved Stream-Elective Baskets

H.1 Approved Stream-Elective Baskets

The stream pathway requires 1.0 credit of approved upper-year stream electives, consisting of 0.5 credit from Basket A and 0.5 credit from Basket B. These approved basket selections occupy the remaining two Year 4 engineering elective slots after ELEC 4CP0 and ELEC 4SPD are placed in the other two Year 4 engineering elective slots.

Basket A: Photonics Devices, Materials, and Optical Systems

- ELEC 4700 The Physics and Modeling of Advanced Devices and Technologies
- ELEC 4702 Fiber Optic Communications
- ELEC 4704 Nanoscale Technology and Devices
- ELEC 4705 Electronic Materials, Devices and Transmission Media
- ELEC 4906 Special Topics, only where the topic has been explicitly approved by the Associate Chair (Undergraduate) as aligned with photonics, optical devices, quantum photonics, or related optical systems

Basket B: Optoelectronic Circuits, Interfaces, and Integration

- ELEC 4706 High-Speed Electronics: Circuits and Systems
- ELEC 4707 Analog Integrated Electronics
- ELEC 4609 Integrated Circuit Design and Fabrication
- ELEC 4906 Special Topics, only where the topic has been explicitly approved by the Associate Chair (Undergraduate) as aligned with optical transceivers, TIAs, laser drivers, mixed-signal photonics interfaces, or related implementation topics

The compulsory core already spans both photonics and optoelectronics, so these baskets are used as controlled mechanisms for additional depth and emphasis rather than as the sole source of the stream's identity. Not every listed course would necessarily be offered every year, and ELEC 4906 is not automatically valid for the stream. Any Basket A or Basket B use of ELEC 4906 requires topic-specific approval by the Associate Chair (Undergraduate).

H.2 Illustrative Approved Stream-Elective Combinations

The examples below are illustrative only. They do not create additional requirements, and they do not create multiple formal substreams. Every stream student still completes the same fixed core together with one approved Basket A choice and one approved Basket B choice.

1. **Devices and optoelectronic circuits:** Basket A: ELEC 4700; Basket B: ELEC 4707.
2. **Optical communications and high-speed implementation:** Basket A: ELEC 4702; Basket B: ELEC 4706.
3. **Device technology and IC integration:** Basket A: ELEC 4704 or ELEC 4705; Basket B: ELEC 4609.
4. **Advanced topic path:** Basket A or Basket B may be satisfied by ELEC 4906 only where the topic has been explicitly approved by the Associate Chair (Undergraduate) for the relevant basket within the stream pathway.

I Anticipated Engineering Faculty Board Questions

I.1 Faculty FAQ (Questions Only)

The following questions are anticipated for Engineering Faculty Board discussion of the proposed stream:

1. Does this stream add credits or overload the existing Electrical Engineering degree?
2. Why is ELEC 2602 the required course being replaced?
3. Can a student switch into the stream, and if so, at what point in the program?
4. Could a student already in third year take the ELEC 2PH0 replacement for ELEC 2602 and still switch into the stream?
5. Can students in the regular Electrical Engineering pathway take any of the new stream courses as electives, or are those courses intended to remain within the sequenced stream pathway?
6. Are the new courses, ELEC 2PH0, ELEC 4CP0, ELEC 4SPD, and ELEC 4909, sufficiently defined and realistically deliverable?
7. What laboratories, if any, will need to be built or expanded for the new courses, when would that occur, and how would it be funded?
8. What exactly is ELEC 4909, and how does it differ from ELEC 4907?
9. What are the instructional, laboratory, space, equipment, and administrative resource implications of the stream?
10. What impact could the stream have on other departments or academic units that contribute to the Electrical Engineering degree?
11. Does the proposed stream change the program-level learning outcomes of the B.Eng. Electrical Engineering degree?
12. Why is the stream named “Photonics and Optoelectronics,” and why is this the right time to introduce it?
13. Does the proposed stream remain within the existing CEAB-accredited Electrical Engineering degree, or does it create accreditation risk?
14. What evidence is there of student demand or employer demand for this stream?
15. How will students be advised clearly enough to follow the stream pathway without timetable or degree-audit confusion?
16. Is the proposed implementation timeline, including the intended launch target, realistic?

I.2 Provisional Responses to Anticipated Engineering Faculty Board Questions

- 1. Does this stream add credits or overload the existing Electrical Engineering degree?**

No. The stream remains a 21.0-credit pathway within the existing B.Eng. Electrical Engineering degree. ECOR 2995 remains the normal 0.0-credit two-term requirement, ELEC 2PH0 replaces ELEC 2602, ELEC 4909 replaces ELEC 4907 one-for-one in the existing capstone slot, and the four existing Year 4 engineering elective slots are used by ELEC 4CP0, ELEC 4SPD, one approved Basket A selection, and one approved Basket B selection. The stream does not add net credits to the degree.

- 2. Why is ELEC 2602 the required course being replaced?**

The stream needs an earlier and more appropriate foundational course in photonics and optoelectronics to support the later stream-specific curriculum. Replacing ELEC 2602 with ELEC 2PH0 provides that foundation in a direct way while keeping the overall stream modification modest. It is the single required-course replacement in the model and helps create a coherent sequence from Year 2 through the Year 4 stream courses and capstone.

- 3. Can a student switch into the stream, and if so, at what point in the program?**

In principle, yes, but the stream is intended to be entered early enough for the student to complete ELEC 2PH0 on sequence and then progress through the later stream-specific courses in a coherent way. The normal expectation is that entry would occur before the point at which the Year 2 replacement course is needed.

Later entry may still be possible in some cases, and the approved upper-year basket structure does give somewhat more flexibility than a fully fixed pair of upper-year electives. Even so, entry would still depend on advising, scheduling, prerequisite completion, and whether a feasible remaining plan exists without creating undue complications for the student.

- 4. Could a student already in third year take the ELEC 2PH0 replacement for ELEC 2602 and still switch into the stream?**

Potentially, yes, but this would not be the normal pathway. It would need to be considered on a case-by-case basis, taking into account scheduling, prerequisite sequencing, available capacity, and whether the remaining stream requirements could still be completed in a sensible and timely way.

The approved Basket A and Basket B structure can make some later pathways easier to evaluate than a completely hard-coded upper-year model, but the intent of the stream is still to have a clear internal sequence beginning earlier in the program rather than to rely routinely on late entry.

- 5. Can students in the regular Electrical Engineering pathway take any of the new stream courses as electives, or are those courses intended to remain within the sequenced stream pathway?**

The intended model is that the new stream-specific courses remain part of a sequenced Photonics and Optoelectronics stream pathway rather than functioning as general EE electives. ELEC 2PH0 is intended to serve as the foundational Year 2 course for the new taught fourth-year stream courses, so the ordinary expectation is that students in the regular EE pathway would not take ELEC 2PH0, ELEC 4CP0, ELEC 4SPD, or ELEC 4909 unless they had entered the stream and satisfied the relevant prerequisite structure.

By contrast, the approved Basket A and Basket B options are existing EE electives or ELEC 4906 topics approved by the Associate Chair (Undergraduate) for the relevant basket, and may still be taken by non-stream students where ordinary degree rules, prerequisites, term offerings, and capacity permit. Within the stream, however, those basket courses are used in a specific and auditable way to satisfy the required upper-year stream-elective structure. Detailed prerequisite chains would still be finalized through normal course-approval processes.

6. Are the new courses, ELEC 2PH0, ELEC 4CP0, ELEC 4SPD, and ELEC 4909, sufficiently defined and realistically deliverable?

Yes, that is the intent of the current proposal. The stream has been designed deliberately as a modest and auditable modification rather than as a wholesale restructuring of the degree. The new courses play specific roles within that structure: one Year 2 foundation course, two new taught fourth-year stream courses, and one stream-specific capstone replacement.

The revised model is also more deliverable than a fully prescribed upper-year structure because the remaining 1.0 credit of specialization is carried by approved existing EE electives or ELEC 4906 topics approved by the Associate Chair (Undergraduate) for Basket A or Basket B rather than by additional new required courses. As with any approved stream, finalized outlines, prerequisites, delivery assignments, and detailed implementation would still proceed through the normal academic and calendar processes, but the resulting task remains bounded and manageable.

7. What laboratories, if any, will need to be built or expanded for the new courses, when would that occur, and how would it be funded?

The expectation is that laboratory development would be incremental rather than based on creating an entirely new laboratory environment from scratch. The new second-year and stream-core courses would build on existing optical, electronics, packaging, testing, and design infrastructure where feasible, while the approved basket model allows part of the upper-year specialization to be carried by existing electives that already have established delivery patterns.

Additional laboratory development for the new stream courses would be phased with implementation and handled through normal departmental and university planning processes, together with any partner support that may become available. The intent is to build only what is needed, when it is needed, and at a scale consistent with the initial stream rollout.

8. What exactly is ELEC 4909, and how does it differ from ELEC 4907?

ELEC 4909 is the stream-specific capstone replacement for students in the Photonics and Optoelectronics Stream. It occupies the same two-term, 1.0-credit capstone slot that ELEC 4907 occupies in the regular EE pathway, but it is clearly oriented toward photonics- and optoelectronics-related design projects.

In that sense, ELEC 4909 differs from ELEC 4907 not by adding credits or creating a separate capstone system, but by giving the capstone work a stream-specific technical focus while remaining under normal departmental academic oversight.

9. What are the instructional, laboratory, space, equipment, and administrative resource implications of the stream?

The stream is intended to launch at modest scale and within the existing degree structure, which helps keep the initial resource requirement bounded. That is one reason the proposed curricular delta has been kept intentionally small, with a fixed stream core plus 1.0 credit selected from approved existing electives or ELEC 4906 topics approved by the Associate Chair (Undergraduate) for Basket A or Basket B.

At the same time, any successful stream that increases enrolment or activity can create additional demands in teaching, laboratories, technical support, advising, scheduling, and administration. Those implications would need to be monitored and addressed through normal planning and approval processes as implementation proceeds.

10. What impact could the stream have on other departments or academic units that contribute to the Electrical Engineering degree?

Although the stream-specific curricular changes are primarily housed within Electronics, any material increase in Electrical Engineering enrolment attributable to the stream would have downstream implications for shared teaching and support provided by other academic units contributing to the EE curriculum.

Those effects could include pressure on shared courses, laboratories, scheduling, advising, and administrative support. The expectation is that such effects would be monitored and handled through normal enrolment planning and inter-unit resource discussions.

11. Does the proposed stream change the program-level learning outcomes of the B.Eng. Electrical Engineering degree?

No. The underlying program-level learning outcomes of the accredited B.Eng. Electrical Engineering degree remain unchanged. The stream introduces a focused curricular emphasis in photonics and optoelectronics within that existing degree-level framework.

That emphasis is carried through the fixed core of ELEC 2PH0, ELEC 4CP0, ELEC 4SPD, and ELEC 4909, together with 1.0 credit selected from the approved upper-year stream-elective baskets. The compulsory core already spans both photonics and optoelectronics, while the baskets provide controlled additional depth and emphasis. In that sense, the stream sharpens curricular emphasis rather than redefining the core learning goals of the Electrical Engineering degree.

12. Why is the stream named “Photonics and Optoelectronics,” and why is this the right time to introduce it?

The title “Photonics and Optoelectronics” is intended to be descriptive, focused, and academically honest about the actual content of the stream. It reflects the direction in which departmental expertise has increasingly moved, and it aligns with the areas in which the department is now in a stronger position to offer a coherent curricular focus.

The revised structure also makes the name more accurate pedagogically. The fixed core already spans both photonics and optoelectronics, and the Basket B requirement is deliberate because a stream with this title should include a visible electronics, circuits, and implementation dimension rather than only optical devices or optical communications. It is also timely because industry is seeking highly qualified personnel in this area, and students have commented that they would welcome an opportunity to focus their studies more directly in this direction.

13. Does the proposed stream remain within the existing CEAB-accredited Electrical Engineering degree, or does it create accreditation risk?

The stream remains within the existing CEAB-accredited B.Eng. Electrical Engineering degree. It does not create a separate accredited degree. The proposal has been structured carefully so that the pathway remains 21.0 credits, the capstone replacement is one-for-one, and the stream-specific content is readily identifiable within the existing degree framework.

In the revised model, that stream-specific content is carried by the fixed core of ELEC 2PH0, ELEC 4CP0, ELEC 4SPD, and ELEC 4909, together with 1.0 credit selected from approved Photonics and Optoelectronics stream-elective baskets, for a total of 3.5 credits of readily identifiable stream-specific engineering science and/or engineering design content. Because the baskets are defined in the rules, the model remains auditable. As with any named stream reflected in official credential wording, implementation should continue to be handled carefully and transparently, including normal consultation with the CEAB Secretariat as appropriate.

14. What evidence is there of student demand or employer demand for this stream?

There are several indicators pointing in the same direction. Students have expressed interest in being able to focus more directly in this area, and the stream provides a clearer and more visible way to do that within the existing EE degree.

On the employer side, industry has indicated interest in highly qualified personnel with preparation in photonics and optoelectronics. In particular, Ciena has confirmed so far that 10 co-op positions per summer would be offered for students in this stream, which is a strong early signal of practical employer demand and student opportunity.

15. How will students be advised clearly enough to follow the stream pathway without timetable or degree-audit confusion?

The stream has been designed to be as simple and auditable as possible. It involves one clear Year 2 required-course replacement, a fixed upper-year core of ELEC 4CP0 and ELEC 4SPD, a defined requirement for one Basket A choice and one Basket B choice in the remaining two Year 4 engineering elective slots, and a one-for-one capstone replacement. That structure is easier to communicate and track than either a loosely defined menu or a more elaborate substream model.

Clear advising notes, calendar language, degree-audit logic, and stream information materials would still need to be prepared as part of implementation. The current structure has been intentionally kept simple so those advising and administrative tasks remain manageable.

16. Is the proposed implementation timeline, including the intended launch target, realistic?

Yes, on the current assumptions, the timeline appears realistic. One reason is that the new second-year course would not be needed immediately; it is expected to become the first touchpoint for entering stream students in Winter 2029. That provides time to complete the remaining outline, approval, and implementation work in a disciplined way.

The implementation task is also more manageable in the revised model because the fixed stream core is limited to four clearly defined stream-specific courses, while the remaining 1.0 credit is carried by approved existing EE electives or ELEC 4906 topics approved by the Associate Chair (Undergraduate) for Basket A or Basket B. Laboratory and delivery planning would still need to be completed carefully, but the proposal does not depend on creating a large new upper-year course set all at once.