

Co-Terminal Degree Proposal, Form 802 Attachment

Bachelor of Science in Biomedical Engineering

Master of Computational Engineering

Undergraduate Program

Undergraduate Program Type: Bachelor of Science in Biomedical Engineering

Total Undergraduate Program Credit Hours (including shared credit): 131 hours (Cell and Tissue Engineering Track, CT), 132 hours (Neural Engineering Track, NE) 132 hours (Medical Imaging Track, MI)

Program Description: IIT's undergraduate program in biomedical engineering (BME) facilitates the learning of biomedical engineering fundamentals. This foundation consists of a broad exposure to the biological and physical sciences, mathematics, and fundamental engineering content. In addition, students specialize in one of three BME areas: Cell and Tissue Engineering, Medical Imaging, or Neural Engineering. In all cases, students develop the skills necessary to succeed as professional biomedical engineers, and to thrive in graduate or professional school (e.g. medical, business, law).

Program Purpose: The co-terminal program between the BS in Biomedical Engineering and Master of Computational Engineering (MCE) allows students interested in future careers focused in computational aspects of engineering to enter the job force very competitively positioned to pursue these opportunities within engineering-based industries.

Program Benefits: The Master of Computational Engineering degree was one of six new interdisciplinary engineering degrees approved for Fall 2017. These interdisciplinary degrees reflect contemporary shifts in engineering education and increase the attractiveness of IIT with potential graduate students. By offering these new interdisciplinary graduate degrees as co-terminal programs with our current undergraduate degrees, we are providing our current undergraduate engineering students a path to greater competitiveness while they retain undergraduate financial aid benefits. Furthermore, engineering transfer students often face significant course sequencing challenges within engineering curriculums. Some transfer students solve this problem by pursuing co-terminal programs, and some choose to leave IIT. This co-terminal program will increase the options available to transfer students and potentially improve retention.

Course requirements and sample curriculum: Course requirements and a sample curriculum are included in this document.

Competitive Programs: BS BME is a competitive degree offered by many institutions. However, most schools do not offer a co-terminal BS BME and graduate degree in computational engineering.

Market Analysis: BS BME is a competitive degree offered by many institutions. The Master of Computational Engineering is a new degree program (Fall 2017). Please refer to the market analysis for the MCE degree provided in the 2017 degree program application for further information.

Marketing and Advertising: Both degrees are currently marketed. The co-terminal degree will be included in current co-terminal degree marketing and additional marketing by the Armour College of Engineering.

Enrollment Estimates: Estimated enrollment in this co-terminal program is 2-4 new students/year.

Retention Estimates: It is anticipated that retention may be improved for transfer students as the co-terminal program allows more flexibility for scheduling each semester.

Economic Analysis: There are no additional costs for the co-terminal program. It is expected that this co-terminal program will draw from a group of students separate from those who pursue the other BME co-terminal programs (MAS Chemical Engineering and MAS Biomedical Imaging and Signals, administered by the ECE department). Therefore, it is expected that additional tuition revenue will be generated equivalent to 24 credits/student enrolled in the program.

Graduate Program

Graduate Program: Master of Computational Engineering

Program Overview: Students who thrive on solving complex equations and are energized by delving into computer simulations and mathematical algorithms would be a good fit for the Master of Computational Engineering program. This new and growing multidisciplinary field offers career possibilities ranging from calculating the trajectory of satellites to designing aircraft to simulating molecular mechanics. Students will learn computational methodologies, tools, analysis, processing, and modeling capabilities that are central to succeeding in this dynamic engineering field. There are four tracks: (a) Computational Mechanics, (b) Computational Chemical Engineering, (c) Biomedicine, or (d) Optimization, Machine Vision, and Decision Making.

Program Justification: The Armour College of Engineering is committed to be a lifelong educational partner with our community, from pre-college to professional advancement. The MCE degree program contributes to this commitment by enhancing the overall offerings within the Armour College of Engineering. It is anticipated that approximately 20 students will enroll in the MCE program Fall 2018. The BS BME/MCE co-terminal degree is anticipated to add 2-4 additional students. A detailed justification for the MCE program can be found in the 2017 MCE degree application.

Program Resources: The co-terminal program does not require additional resources. The MCE curriculum leverages existing courses.

Program description: A detailed list of courses required for each track in the co-terminal degree follows. Students should have a minimum 3.0 GPA to be accepted into the co-terminal program. Students will be accepted into the program beginning Fall 2018.

Description of courses shared between Undergraduate and Graduate programs:

a) Shared required courses:

UG, MI Track: BME 445 as GRAD: BME 445, Biomedical Specialization, or as approved elective for any track

UG, CT and NE Track: none

b) Shared elective courses:

UG, MI Track: (1) BME elective (500-level) as GRAD: (1) core, specialization or approved elective

UG,CT and NE Track: (2) BME electives (500-level) as GRAD: (2) core, specialization or approved electives

c) Course substitutions or exceptions:

MI Track: Students may substitute a different 400 or 500 level required or elective course in the UG BME MI program of study as an MCE core, specialization or elective with advisor approval

Bachelor of Science in Biomedical Engineering/Master of Computational Engineering

Required Courses	Credit Hours		
	UG	grad	total
Biomedical Engineering Core Requirements BME 100, 310, 315, 330, 405, 419, 422, 420, 433, 453	26	0	26
Cell and Tissue Track Requirements^a BME 301, 320, 335, 418, 424, 482, BME electives^c (6 cr) CHE 202, MMAE 200, ECE 211, CHEM 235, BIOL 403	32	0	38
Neural Engineering Track Requirements^a BME 309, BME 325, BME 438, BME 443, BME 445, BME electives^c (9 cr) ECE 211, ECE 213, ECE 218, MATH 333, technical elective (3 cr)	33	0	39
Medical Imaging Track Requirements^a BME 309, BME 325, BME 438, BME 443, BME 445^c , BME electives^c (3 cr) CS201, ECE211, ECE 213, ECE 437, ECE 481, PHYS 224, MATH 333	33	0	39
Master of Computational Engineering Core Requirements^c (select 3 courses) ECE 505, ECE 511, MMAE 501, MMAE 502, MMAE 451, MMAE 532, CHE 506, CHE 536, MATH 577, MATH 581, BME 522, BME 553	3	9	9
Computational Mechanics Specialization^{b,c} (select 4 courses) MMAE 450, MMAE 517, MMAE 518, MMAE 570, MMAE 532, CAE 530, CAE 534 CAE 535, CAE 536, CHE 536, CHE 560, MMAE 597, CAE 597	3	12	12
Computational Chemical Engineering Specialization^{b,c} (select 4 courses) CHE 439, CHE 535, CHE 536, CHE 597	3	12	12
Biomedicine Specialization^{b,c} (select 4 courses) BME 445^c , BME 523, BME 524, BME 525, BME 538, BME 597, ECE 565, CHE 585, CHE 516/BME 517	3	12	12
Optimization, Machine Vision, and Decision Making Specialization^{b,c} (select 4 courses) 3 ECE 533, ECE 535, ECE 563, ECE 565, ECE 567	3	12	12
Master of Computational Engineering Elective Requirements^c (select 3 courses) Additional courses from core or any specialization	0	9	9
Science Requirements BIOL 115, BIOL 117, CHEM 124, CHEM 125, PHYS 123, PHYS 221	20	0	20
Mathematics & Computer Science Requirements MATH 151, MATH 152, MATH 251, MATH 252, CS 104	20	0	20
Humanities and Social Science Requirements	21	0	21

I PRO	6	0	6
Total	131-132	30	155-156

(131-132 BME UG) + 30 (MCE) -6 (shared credits) = 155-156 (total)

^aonly one track is required for the BME UG program

^bonly one track is required for the MCE program

^cshared courses between undergraduate and graduate curricula (6 cr)

MI: BME 445 and BME elective selected from MCE core, specialization or approved elective (6 cr)

CT & NE: BME electives selected from MCE core, specialization or approved electives (6 cr)

^dMI Track: Students may substitute a different 400 or 500 level required or elective course in the UG BME MI program of study as an MCE core, specialization or elective with advisor approval

Sample Schedule: Cell and Tissue Track

Semester 1	Credits	Semester 2	Credits
BME 100 Introduction to the Profession	2	CHEM 125 Principles of Chemistry II	4
CHEM 124 Principles of Chemistry I	4	MATH 152 Calculus II	5
CS104 Intro to Programming for Engineers	2	PHYS 123 General Physics I	4
MATH151 Calculus I	5	Hum/SS Elective	3
Hum/SS Elective	3		
Total	16	Total	16
Semester 3	Credits	Semester 4	Credits
CHE 202 Material & Energy Balances	3	BIOL 115 Human Biology	3
ECE 211 Circuit Analysis I	3	BIOL 117 Experimental Biology	1
MATH 252 Introduction to Differential Equations	4	BME 315 Instrumentation Lab	2
MMAE 200 Introduction to Mechanics	3	MATH 251 Multivariate and Vector Calculus	4
Hum/SS Elective	3	PHYS 221 Physics II: EM and Optics	4
		Hum/SS Elective	3
Total	16	Total	17
Semester 5	Credits	Semester 6	Credits
BME 330 Analysis of Biosignals and Systems	3	BME 301 Biofluid Mechanics	3
BME 405 Physiology Laboratory	2	BME 310 Biomaterials	3
BME 422 Mathematical Methods in BME	3	BME 320 Biofluids Laboratory	1
BME 453 Quantitative Physiology	3	BME 335 Thermodynamics of Living Systems	3
CHEM 235/237 Organic Chemistry I	3/4	BIOL 403 Biochemistry	4
Hum/SS Elective	3	IPRO I	3
Total	17/18	Total	17
Semester 7		Semester 8	
BME 418 Reaction Kinetics	3	BME 420 Design concepts in BME	3
BME 419 Intro to Design Concepts in BME	2	BME 424 Quant. Aspects of Tissue Engineering	3
BME 482 Mass Transport for BME	3	MCE Core	3
MCE Core	3	Senior Seminar	0
MCE Core	3	MCE Specialization	3
		IPRO II	3
Total	14	Total	15
Semester 9		Semester 10	
BME 433 Applications of Statistics	3	BME Elective	3
MCE Specialization	3	MCE Specialization	3
MCE Elective	3	MCE Elective	3
BME Elective	3	Hum/SS Elective	3
Hum/SS Elective	3		
Total	15	Total	12

Sample Schedule: Neural Engineering Track

Semester 1	Credits	Semester 2	Credits
BME 100 Introduction to the Profession	2	CHEM 125 Principles of Chemistry II	4
CHEM 124 Principles of Chemistry I	4	MATH 152 Calculus II	5
CS104 Intro to Programming for Engineers	2	PHYS 123 General Physics I	4
MATH151 Calculus I	5	Hum/SS Elective	3
Hum/SS Elective	3		
Total	16	Total	16
Semester 3	Credits	Semester 4	Credits
PHYS 221 Physics II: EM and Optics	4	BIOL 115 Human Biology	3
ECE 211 Circuit Analysis I	3	BIOL 117 Experimental Biology	1
ECE 218 Digital Systems + Lab	4	BME 315 Instrumentation Lab	2
MATH 252 Introduction to Differential Equations	4	ECE 213 Circuit Analysis II + Lab	4
Hum/SS Elective	3	MATH 251 Multivariate and Vector Calculus	4
		Hum/SS Elective	3
Total	18	Total	17
Semester 5	Credits	Semester 6	Credits
BME 309 Imaging and Sensing	3	BME 310 Biomaterials	3
BME 330 Analysis of Biosignals and Systems	3	BME 325 Bioelectronics Lab	1
		BME 443 Biomedical Instrumentation & Electronics	3
BME 405 Physiology Laboratory	2	BME 445 Quantitative Neural Function	3
BME 422 Mathematical Methods in BME	3	MATH 333 or CHEM 237	3/4
BME 453 Quantitative Physiology	3	IPRO I	3
Hum/SS Elective	3		
Total	17	Total	16/17
Semester 7		Semester 8	
BME 419 Intro to Design Concepts in BME	2	BME 420 Design concepts in BME	3
Technical Elective or CHEM 239	3	BME 438 Neuroimaging	3
BME Elective	3	IPRO II	3
MCE Core	3	Senior Seminar	0
MCE Core	3	MCE Core	3
		MCE Specialization	3
Total	14	Total	15
Semester 9		Semester 10	
BME 433 Applications of Statistics	3	BME Elective	3
BME Elective	3	MCE Specialization	3
MCE Specialization	3	MCE Elective	3
MCE Elective	3	Hum/SS Elective	3
Hum/SS Elective	3		
Total	15	Total	12

Sample Schedule: Medical Imaging Track

Semester 1	Credits	Semester 2	Credits
BME 100 Introduction to the Profession	2	CHEM 125 Principles of Chemistry II	4
CHEM 124 Principles of Chemistry I	4	MATH 152 Calculus II	5
CS104 Intro to Programming for Engineers	2	PHYS 123 General Physics I	4
MATH151 Calculus I	5	Hum/SS Elective	3
Hum/SS Elective	3		
Total	16	Total	16
Semester 3	Credits	Semester 4	Credits
PHYS 221 Physics II: EM and Optics	4	BIOL 115 Human Biology	3
ECE 211 Circuit Analysis I	3	BIOL 117 Experimental Biology	1
CS 201 Accelerated Intro to Computer Science	4	BME 315 Instrumentation Lab	2
MATH 252 Introduction to Differential Equations	4	ECE 213 Circuit Analysis II + Lab	4
Hum/SS Elective	3	MATH 251 Multivariate and Vector Calculus	4
		Hum/SS Elective	3
Total	18	Total	17
Semester 5	Credits	Semester 6	Credits
BME 309 Imaging and Sensing	3	BME 310 Biomaterials	3
BME 330 Analysis of Biosignals and Systems	3	BME 325 Bioelectronics Lab	1
		BME 443 Biomedical Instrumentation & Electronics	3
BME 405 Physiology Laboratory	2	BME 445 Quantitative Neural Function	3
BME 422 Mathematical Methods in BME	3	MATH 333 or CHEM 237	3/4
BME 453 Quantitative Physiology	3	IPRO I	3
Hum/SS Elective	3		
Total	17	Total	16/17
Semester 7		Semester 8	
BME 419 Intro to Design Concepts in BME	2	BME 420 Design concepts in BME	3
PHYS 224 or CHEM 239	3	BME 438 Neuroimaging	3
ECE 437 Digital Signal Processing	3	ECE 481 Image Processing	3
MCE Core	3	Senior Seminar	0
MCE Core	3	MCE Core	3
		MCE Specialization	3
Total	14	Total	15
Semester 9		Semester 10	
BME 433 Applications of Statistics	3	BME Elective	3
MCE Specialization	3	MCE Specialization	3
MCE Elective	3	MCE Elective	3
IPRO II	3	Hum/SS Elective	3
Hum/SS Elective	3		
Total	15	Total	12