MINNESOTA STATE COLLEGES AND UNIVERSITIES[1]
ENGINEERING BROAD FIELD AGREEMENT

This Agreement is entered into between Minnesota State University, Mankato; St. Cloud State University; Winona State University; University of Minnesota-Twin Cities; and any system college approved to offer the Associate of Science Engineering Broad Field degree program. Any system college that offers the Associate of Science Engineering Broad Field program is a party to this agreement. This Agreement and any amendments and supplements, shall be interpreted pursuant to the laws of the State of Minnesota.

This agreement is applicable to university engineering degree programs listed in Table 2 and System colleges approved to offer the Associate of Science Engineering Broad Field degree program as outlined in Table 1. This agreement will facilitate credit transfer and provide a smooth transition from one related program to another. It is mutually agreed that:

Admission and Graduation Requirements

A. System university admission and program admission requirements apply equally to both direct entry students and to students who transfer under this agreement.

B. Baccalaureate engineering degree programs may have limited enrollment capacity with seats available on a competitive basis.

C. Completion of the Associate of Science Engineering Broad Field degree program does not guarantee admission to a baccalaureate degree program.

D. Students accepted into a system university must fulfill the baccalaureate program graduation requirements.

Transfer of Credits

A. Engineering Broad Field degree program required courses are listed in Table 1. Minnesota State colleges and universities will provide advising to students on the selection of elective courses most suited to the student's intended engineering baccalaureate major.

B. Students should consult with a transfer specialist, counselor, or an advisor on the selection of General Education courses. See appendices for more specific guidance. General education courses named in Table 1 transfer and count toward the university engineering baccalaureate degree program requirements when in accordance with university Gen Ed requirements. MnTC Goal Areas are determined by the sending college when transferred into Minnesota State universities (not into the University of Minnesota).

C. All engineering specialty courses labeled Required (Req) within the chosen specialty area in Table 1 transfer and count toward the university baccalaureate degree program requirements. Students must consult with an advisor or transfer specialist to determine whether courses labeled Advised (Adv) will transfer to a particular university engineering program. Specific advising information, including the name of the college and the specific university engineering program should be retained by students for reference in the case of an appeal.

D. Students must meet at least six of the ten Minnesota Transfer curriculum goal areas to receive the Associate of Science of Engineering Broad Field degree. Students who want to meet more than six goal areas should consult with an advisor, counselor, or transfer specialist regarding goal area requirements that fit best with the selected engineering program.

[1] The Board of Trustees of the Minnesota State Colleges and Universities is authorized by Minnesota Statutes, Chapter 136F to enter into Agreements and has delegated this authority to colleges and universities.

Table 1: Engineering Broad Field Course Requirements	
General Education*	Credits**
English Composition	3-4
***Humanities, History, Behavioral or Social Sciences. Two course that satisfy Goal Areas 5 and 6. At least one of these courses must also satisfy one of goal area 7, 8, 9, or 10. For select Minnesota State university programs, Macroeconomics or Microeconomics may be required (see appendices 1, 2, 3, and 4).	6
Calculus I	4-5
Calculus II	4-5
Multivariable Calculus	4-5
Differential Equations	3-5
Physics I (calculus-based, with lab)	4-6
Physics II (calculus-based, with lab)	4-6
Chemistry I (Computer Engineering students substitute MnTC course as advised)	4-5
* MnTC Goal Area is determined by the sending college. **Course credits may vary by college ***Please see appendices 1, 2, 3, and 4 for additional guidance to select general education courses for each of the four universities. Minimum MnTC Subtotal	36-47

Engineering Specialties: Programs must offer all required courses for at least three of the seven engineering specialties.

Students at two-year colleges must select a <u>minimum</u> of 4 courses and 12 credits from a single engineering specialty (e.g. electrical , computer, general, mechanical, etc.).
Key: "**Req**" = required **university** program course; "**Adv**"= see advisor/transfer specialist to confirm transfer to university program;

Civil	Computer	Electrical	General	Mech	Manuf	Composite	Environ-mental		College Credits**
Adv	Adv	Adv	Req	Req	Req	Req	Req UMN-not required	Intro to Engineering	2-4
	Req	Req	Req	Req	Req	Req	Req UMN-not required	Comp Programming	3-4
Req		Adv	Req	Req	Req	Req	Req	Statics	3
Req		Adv	Req	Req	Req	Req	Req UMN-not required	Dynamics	3
Req			Req	Req	Req	Req	UMN-Adv	Deformable Body Mechanics	3
Req UMN-Adv	Adv MSU, Mankato	Adv	Adv	Req	Req	Adv	Adv	Thermodynamics	3
	Req	Req	Req	Req	Req	Req		Circuits I (with lab)	4-5
	Req	Req						Circuits II	3-4
	Req	Req		Adv				Digital logic	2-4
UMN-Adv	Adv			Adv	Adv	Adv	Adv UMN-not required	Probability & Statistics	3-4

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Adv	Adv	Adv	Adv	Adv	Adv	Req	Req	Chemistry II	4-5
						Req	Req SCSU-Adv UMN-Organic Chem I –Req; Organic Chem II-not required	Organic Chemistry I & II	8-10
A total of 60 credits is required to complete the degree program. If necessary, complete additional general education or engineering specialty courses. See a transfer specialist, advisor, or counselor for guidance on courses that will best transfer to the selected university engineering program.									60

APPLICABLE PROGRAMS. To complete an engineering baccalaureate degree program, courses from the Associate of Science Engineering Broad Field degree program will transfer to university programs listed in Table 2 according to the terms of this agreement.

Table 2. Engineering Broad Field, AS, articulates to the following related university programs[2]

Minnesota State University, Mankato (limited seats available on a competitive basis)

- Civil Engineering
- Computer Engineering
- Electrical Engineering
- General Engineering
- Mechanical Engineering

St. Cloud State University (limited seats available on a competitive basis)

- Computer Engineering
- Electrical Engineering
- Manufacturing
- Mechanical Engineering
- Environmental Engineering

Winona State University (limited seats available on a competitive basis)

- Composite Materials Engineering
- General Engineering

University of Minnesota-Twin Cities (limited seats available on a competitive basis)

- Computer Engineering
- Electrical Engineering
- Manufacturing
- Mechanical Engineering
- Civil Engineering
- Environmental Engineering

Terms of Agreement

A. This Articulation Agreement is effective on October 1, 2018, and shall remain in effect until the end date of October 1, 2023, or five years, whichever occurs first. This Articulation Agreement will be reviewed by all parties within five years of the effective date, on or before April 1, 2023 (within six months of the end date).

B. The Chief Academic Officers or designees of the parties to this agreement will implement the terms of this agreement, including identifying and incorporating any changes into subsequent agreements, assuring compliance with system policy, procedure and guidelines, and conducting a periodic review of this agreement.

[2] See advisor, transfer specialist, or counselor for guidance or questions regarding the selected baccalaureate program.

C. Program curriculum and requirements may change as agreed by all parties.

Appendix 1

Minnesota State University, Mankato

The engineering programs at Minnesota State Mankato follow a modified General Education curriculum which does not strictly follow the Goal Area format at other system institutions. Specific questions can be directed to the Advising Office for the College of Science, Engineering and Technology at csetadvising@mnsu.edu, with specific General Education requirements for each program also readily available online. In general, the following points will be helpful:

1 – Each of the engineering programs through Minnesota State Mankato requires either Macroeconomics or Microeconomics, (equivalent to ECON 201 or ECON 202 at Minnesota State Mankato). It is strongly recommended that one of these two courses be taken in meeting the "Humanities, History, Behavioral or Social Sciences" requirement of the Engineering Broad Field.

2 – The majority of the Goal Area 5 and Goal Area 6 courses for most institutions WILL count towards Gen Ed requirements for the Minnesota State Mankato engineering programs, and these engineering programs strive to accommodate student coursework to the extent possible. A few course types are NOT allowed towards engineering program Gen Ed requirements, including studio-type courses (i.e., Photography, Introduction to Dance, Musical Performance, etc.) and limited additional categories. Students and advisors are encouraged to connect with csetadvising@mnsu.edu or their specific programs for clarification with respect to appropriate Goal Area 5 and Goal Area 6 courses.

Appendix 2

St. Cloud State University

Mechanical or Manufacturing Engineering: When fulfilling Goal Area 5, students should complete either a Microeconomics or a Macroeconomics course (equivalent to ECON 205 or ECON 206 at SCSU). Students are encouraged to complete a single course that fulfills two goal areas – ideally a single course that fulfills both Goals 6 and 8 or Goals 2 and 6. Completing Statics, Dynamics, and Circuits I would have the most value prior to transfer in these specialties.

Electrical and Computer Engineering: Students are encouraged to complete courses that fulfill multiple goal areas. Students are encouraged to complete a single course that fulfills two goal areas – ideally a single course that fulfills both Goals 6 and 8, Goals 1 and 9, or Goals 2 and 6.

Environmental Engineering: Though it will be counted as an elective in the program, students are not required to complete Physics II in the program. Instead, students are encouraged to complete a Biology I course (equivalent to BIOL 151 at SCSU) prior to transfer. Students should avoid taking a Goal 10 course prior to transfer. Any Goal 5 or 6 course taken should simultaneously address goals 7-9.

Appendix 3

Winona State University

Composite Materials Engineering: A one-semester organic chemistry survey course with laboratory, equivalent to WSU's CHEM 340, meets degree requirements. The two-semester organic chemistry sequence with lab is also appropriate. Students are required to complete a minimum of 15 unique credits within Goal Areas 5-10, with at least one 3 or 4-credit course in each goal area. Students are encouraged to choose courses that fulfill multiple goal areas.

General Engineering: Students are required to complete a minimum of 15 unique credits within Goal Areas 5-10, with at least one 3 or 4-credit course in each goal area. Students are encouraged to choose courses that fulfill multiple goal areas.

Appendix 4

University of Minnesota-Twin Cities

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Minnesota State Colleges and Universities and University of Minnesota - Twin Cities
Engineering Broad Field Agreement Addendum

Table 1-UMTC: Engineering Broad Field Course Requirements (University of Minnesota - Twin Cities Engineering Specialties)

Key: "**Req**" = required **University** program course; "**Adv**" = see advisor/transfer specialist to confirm transfer to University program

AEM	BBE	BME	ChemE	CivE	CompE	EE	GeoE	ISyE*	MatS	ME	
Req	Req	Req	Req	Req	Req	Req	Req	Req	Req	Req	Linear Algebra**
										Req	Intro to Engineering
Req		Adv		Adv	Req	Req	Adv	Req		Req	Comp Programming
Req	Req			Req			Req		Req	Req	Statics
Req				Adv			Adv				Dynamics
Req				Req			Req		Req	Req	Deformable Body Mechanics
Adv				Adv		Adv	Adv			Req	Thermodynamics
Req				Adv	Req	Req	Adv			Req	Circuits I (with lab)
					Req	Req					Digital Logic
					Req	Req					Circuits II
	Req	Req		Req			Req	Adv			Probability and Statistics
	Req	Req	Req	Req		Adv	Req		Req		Chemistry II***
	Adv	Req	Req	Adv			Adv		Req		Organic Chemistry I
			Req								Organic Chemistry II

*The Industrial and Systems Engineering (ISyE) degree requires appropriate Microeconomics and Principles of Marketing courses in addtion to those listed above.
**It is in the student's best interest to complete Linear Algebra or a combined Linear Algebra/Differential Equations course before transfering with the AS degree.
***Chemistry II is required for transfer admission for the programs notated with "Req".

Grades of C- or better must be received in the required math, science, and specialty courses listed above in order to earn transferable degree credit.

Overall time to earn a University degree will vary by program and individual student. Time to degree is dependent on courses completed before transfer, the sequencing and availability of required University courses, among other factors. In some cases, a student will need to complete a minimum of three years at the University. Use of CSE's four year graduation plans, http://cse.umn.edu/gradplans, to determine the most efficient transfer is recommended

Environmental Engineering:

Linear Algebra is required.

Industrial & Systems Engineering: Microeconomics is advised; Macroeconomics is NA

By my signature below, I support the terms of this "MINNESOTA STATE COLLEGES AND UNIVERSITIES ENGINEERING BROAD FIELD ARTICULATION AGREEMENT"

Marilyn Wells, Provost and Senior Vice President for Academic Affairs *Minnesota State University, Mankato* Electronic signature on file. **Date**:
Dan Gregory , Interim Provost and Vice President for Academic Affairs *St. Cloud State University* Electronic signature on file. **Date**:
Patricia Rogers, Provost and Vice President for Academic Affairs *Winona State University* Electronic signature on file. **Date**:
Bob McMaster, Vice Provost and Dean, Undergraduate Education *University of Minnesota-Twin Cities* Electronic signature on file. **Date:**

Engineering Core & Elective Course Descriptions

Introduction to Engineering. Overview of engineering fundamentals and various engineering disciplines (mechanical, electrical, civil, chemical, manufacturing and/or composite materials engineering). Extensive exposure to visual, written and oral communication forms and to computer-based design tools.

Calculus I. This course is a thorough treatment of differentiation and an introduction to integration. Topics include the definition of derivative, limits and continuity, differentiation, applications of the derivative, definite and indefinite integrals, the Fundamental Theorem of Calculus, techniques of integration and applications of integration. (NH)

Calculus II. This course continues the study of the definite and indefinite integrals and leads to a study of improper integrals and infinite series. Topics include advanced techniques of anti-differentiation, numerical integration techniques and error bounding, applications of the integral, improper integrals, an introduction to differential equations, infinite series, parametric equations, and polar coordinates. (NH)

Multivariable Calculus. Multivariable functions and vector functions are studied as the concepts of differential and integral calculus are generalized to surfaces and higher dimensions. Topics include vectors, parametric equations, cylindrical and spherical coordinates, partial and directional derivatives, multiple integrals, line and surface integrals, and the theorems of Green, Gauss, and Stokes.

Differential Equations. Solution techniques for ordinary differential equations including boundary/initial value problems and systems of first-order equations. Topics include linear homogeneous and non-homogeneous differential equations and the Laplace transform. Methods of linear algebra are studied as they apply to the solution of differential equations.

Physics I (calculus-based, with lab). Designed for science and engineering students. Calculus-based physics. Covers elementary mechanics including kinematics, statics, equilibrium and dynamics of particles, work and energy, rotational motion, gravitation, and oscillation. Lecture and laboratory.

Physics II (calculus-based, with lab). A continuation of Physics I. Principles of thermodynamics, electricity and magnetism, light and modern physics. Lecture and laboratory.

Chemistry I. Introduction to the basic principles of chemistry including atomic and molecular structure, bonding, chemical reactions, stoichiometry, thermodynamics and states of matter. Laboratory will reinforce lecture concepts.

Computer Programming. A lecture-laboratory course. Formulate an overall solution algorithm and solve engineering and scientific problems utilizing spreadsheets, programming language(s), and mathematical software. Topics include engineering and scientific problems that employ statistics, algebra, calculus, linear algebra, optimization, and image processing in their solutions. Use of computers as a mean for technical communication is stressed.

Statics. Application of equilibrium equations to analyze simple engineering structures and machines, including the nature and influence of friction. Elementary theory of statically determinate framed structures.

Mechanical systems and rigid body model. Equilibrium, kinematics, and dynamics of plane systems. Designed to develop the ability to analyze and solve engineering problems.

Dynamics. Kinematics: translation, rotational, plane motion and relative motion of particles and rigid bodies. Planar kinematics of rigid bodies. Kinetics of particles and rigid bodies by methods of force-mass-acceleration, work energy, impulse and momentum, introduction to vibrations.

Deformable Body Mechanics. This course is an introduction to the linear stress-strain behavior of engineering materials. Topics will include stresses due to uniaxial loading, bending and torsion; stress transformations, beam deflections, indeterminate structures and column buckling.

Thermodynamics. Basic concepts, First and Second Law of Thermodynamics, properties and phase changes of pure substances, ideal gases, energy analysis of closed and open systems, enthalpy, entropy, reversibility, and Carnot and gas power cycles.

Circuits I (with lab). Physical principles underlying circuit element models. Resistive circuits, Kirchhoff's laws, independent and dependent sources, node-voltage and mesh-current methods, op-amps, inductors, and capacitors. First- and second-order

circuits. Diodes, BJTs, FETs, and elementary amplifiers. Experiments with simple circuits and electronics. Familiarization with measurement tools and equipment.

Circuits II. Elements of signal and linear system analysis. Sinusoidal steady state analysis, Laplace transforms, two-port circuits, frequency selective circuits, active filter circuits, single stage transistor amplifier frequency response of BJT and FET amplifiers.

Digital Logic. This is the first half of an introduction to digital logic. It is recommended for mechanical, aerospace, computer and electrical engineering students. Topics include Boolean algebra, logic gates, Karnaugh mapping and analysis of combinational circuits.

Probability & Statistics. Introduction to basic ideas and fundamental laws of probability. Topics include an introduction to combinatorics, probability axioms, conditional probability, discrete random variables, common discrete distributions, expectation, generating functions, limit theorems, and continuous random variables.

Chemistry II. An in-depth study of the principles of chemistry including atomic structure, the chemical bond, solutions, thermodynamics, kinetics, acid-base theory, oxidation-reduction, complex ion equilibrium, and electrochemistry. Organic and inorganic examples are used when appropriate throughout the courses, and a short unit on organic chemistry is included. Laboratory and lecture are coordinated.

Organic Chemistry I & II. A thorough study of the chemistry of organic compounds, with emphasis on structure, properties, synthesis, purification, principles and mechanisms of reactions, instrumental methods, compound identification, and important biological and economic applications.