UNIVERSITY OF MICHIGAN
College of Engineering
Curriculum Committee Meeting
Tuesday, February 21, 2023

Attending: Xiaogan Liang (Chair), Achilleas Anastasopoulos, Robert Bordley, Diann Brei, Yavuz Bozer, Saadet Guralp, Roman Hryciw, Odest Chadwicke Jenkins, Xianzhe Jia, Amir Kamil, Leena Lalwani, Cameron Loutitt, Kathleen Panagis, Ken Powell, Eric Rutherford, Rachael Schmedlen, Katie Snyder, Roxanne Walker, Steven Yalisove, Won Sik Yang

Support Staff: Stacie Benison, Mercedes Carmona, Betsy Dodge, Matthew Faunce

Call to Order: 1:34pm

Adjourned: 2:39pm

AGENDA

1. Approval of 2.7.2023 Meeting Minutes (Page 2) - **APPROVED**
2. NERS-ISD SUGS Program Proposal – Action Item (Page 4) - **APPROVED**
    a. ISD has had success with their newly developed curriculum as well as their SUGS pathways with various CoE departments. They are interested in adding NERS to the list of SUGS partnerships and may wish to add others in the future. Developing a SUGS pathway with ISD and NERS is proposed for all MEng programs. This will exclude Master of Science programs at this time, but this may be added in the future.
    b. To be eligible to apply for the program, undergraduate students will need 80 or more NERS undergraduate credit hours, a 3.2 GPA, and completion of the standard MEng application and review process. To graduate from the proposed SUGS program, students must meet their requirements for both their master's degree program and their undergraduate degree program. A maximum of 15 hours taken outside ISD may count towards the MEng. Degree, with 9 credit hours of double counting allowed with NERS. NERS and ISD departments would co-advise students in the preliminary process for the SUGS program. The courses within the proposed curriculum are reviewed regularly by the departments along with review of the curriculum with the CoE ADUE.
    c. A comment was made that the proposed departments may wish to evaluate the need for three letters of recommendation for admission to the program.
        i. Diann will take this back to their department to discuss any potential changes to this.
    d. A question was raised regarding developing a standardized process for SUGS programs to be approved within all CoE majors.
        i. There was some positive support for having more opportunities for students to customize their degree options.
        ii. Xiaogan mentioned that this item will be brought to Kevin for discussion.
        iii. A suggested proposed structure for this process is creating a template for what standard SUGS partnerships would look like with all CoE departments and then ask departments if they wish to opt into this process.
            1. Additional features of the structure that should be considered in future discussion may include what requirements students must meet depending on the department that they are entering, GPA requirements, double counting rules across CoE, and how admissions to programs may be handled.
                a. A note was made that some departments only allow 6 credits of double counting as opposed to 9 credits.
3. CSE and ECE Subject Codes Proposal – Action Item (Page 38) - **APPROVED**
    a. CSE and ECE are divisions within the EECS Department, but due to large size and number of courses, there are not enough numbers to support the continued development of new graduate-level courses. There is also student confusion on which courses count towards an ECE and CSE program.

b. EECS is proposing the creation of separate ECE and CSE subject codes and transitioning most 500-level courses to these divisions, with some 500 level or above courses that will remain as EECS if there is overlap in applying towards both ECE and CSE graduate programs. At this time, the EECS designation will stay in place for 400 level and below courses.
c. About 120 CARFs will need to be submitted to transition these courses, some of which are cross listed with other departments and EECS will need to work with these departments to develop these changes.
d. This proposal seeks to obtain approval from the CCC to begin this work prior to the creation of the CARFs.
e. There were a few mentions of support of this idea from CCC members and upon a vote of the CCC, this proposal has been approved.

4. HLC Annual Audit Project Updates – Informational Item (Page 44)
    a. The CAEN Administrative Burden Group will assist the CCC with this work to develop a process to coordinate the work with curriculum experts (Mike Solomon and Christine Gerdes) as determined by Provost's Office. The HLC Annual Audit Working Group has been developed, which includes members of the CoE Registrar's Office staff (Betsy Dodge, Stacie Benison, and Chevette White), CCC Chair Xiaogan Liang, and will include participation from faculty/CCC members (to be determined). The purpose of this work is to ensure Title IV student financial aid eligibility and that CoE is following applicable guidelines. Winter 2023 is planned as the discovery and planning phrase, in which the working group will evaluate the effectiveness of the HLC Report provided by the University Registrar's Office and will identify the HLC annual audit process going forward. The working group will then help implement the process beginning Fall 2023. The project will officially end in December 2023, but the process that is identified will continue annually.
    b. Benchmarking update - Many of the schools and colleges did not respond or did not have a process in place when benchmarking was completed.
    c. A question was raised regarding what does not apply within the risk example. Further discussion will need to take place with the curriculum experts on this topic, and in developing a process to move forward with an annual review of CoE courses, this process seeks to limit the associated risks for CoE.
    d. A question was raised about the recipients of these updates, which up to this point have primarily been Undergraduate and Graduate Chairs, to ask whether Undergraduate and Graduate Program Advisors would be looped into these conversations at the department level as well.
        i. Xiaogan mentioned that these conversations with constituents across CoE are ongoing and that discussions about how to incorporate the appropriate individuals is something that can continue to be discussed.
    e. A question was raised regarding the action items for CoE Curriculum Committee members. The action items for CCC Members have been outlined below:
        i. CCC members will be asked to discuss and answer questions sent by Undergraduate and Graduate Chairs regarding allowable behaviors (what counts as a contact hour and what does not) to map contact hours.
            1. An example given discussed ENGR 301, a study abroad course that serves as a placeholder for students to remain active in their program while taking courses abroad. Due to the intent of courses such as these, there may be a reasonable explanation for why this course does not meet the policy, and those justifications must be approved by the CCC as allowable.
            2. Another example is ENGR 101, which has some of the course content delivered utilizing self-paced modules on Canvas. The CCC will need to address questions such as these to determine what counts as eligible contact hours.
        ii. Based on discussions and answers to questions received, CCC members will then be asked to update the CoE Policy for Assignment of Contact Hours. Members will receive assistance from the HLC Annual Audit Working Group with these tasks.
    f. An overall summary provided concluded that instructors must be able to justify how the course is setup to follow the contact hours as defined by the Provost's Office.
    g. A question was raised regarding whether course evaluations have been utilized in trying to show compliance in this work. It was discussed that the University Registrar's Office pulls the report for all the schools/colleges from the contact hours listed within CoE classroom records only. This method has its limitations; CoE may have to create our own report for more accurate data.
5. Topics for the Joint CoE/LSA Curriculum Committee Meeting on April 4, 2023
    a. Reciprocity for Minor Approvals between CoE and LSA
    b. HLC Annual Audit Process within CoE
    c. The CoE Incomplete Grade Policy and Course Withdrawals
    d. Sharing of student credit hours

CARF SUMMARIES

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	APPROVED	NOTES & REVISIONS	TABLED
58	EECS	543	DEL		WT 2024	NO	APPROVED		
61	NERS	672	NEW		WT 2024	NO	APPROVED	Cross listed with SPACE 545	

UNIVERSITY OF MICHIGAN
College of Engineering
Curriculum Committee Meeting
Tuesday, February 21, 2023

Attending:

Support Staff:

Call to Order:

Adjourned:

AGENDA

1. Approval of 2.7.2023 Meeting Minutes (Page 2)
2. NERS-ISD SUGS Program Proposal – Action Item (Page 4)
3. CSE and ECE Subject Codes Proposal – Action Item (Page 38)
4. HLC Annual Audit Project Updates – Informational Item (Page 44)

CARF SUMMARIES

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	APPROVED	NOTES & REVISIONS	TABLED
58	EECS	543	DEL		WT 2024	NO			
61	NERS	672	NEW		WT 2024	NO		Cross listed with SPACE 545	

UNIVERSITY OF MICHIGAN
College of Engineering
Curriculum Committee Meeting
Tuesday, February 7, 2023

Attending: Xiaogan Liang (Chair), Achilleas Anastasopoulos, Robert Bordley, Yavuz Bozer, Odest Chadwicke Jenkins, Amir Kamil, Leena Lalwani, Cameron Loutitt, Yulin Pan, Ken Powell, Eric Rutherford, Rachael Schmedlen, Katie Snyder, Roxanne Walker

Support Staff: Stacie Benison, Mercedes Carmona, Betsy Dodge, Matthew Faunce

Call to Order: 1:34pm

Adjourned: 1:56pm

AGENDA

1. Approval of 1.10.2023 Meeting Minutes (Page 2) - APPROVED
2. CSE PhD Program Proposal – Action Item (Page 4) - APPROVED
    a. The proposal seeks to add the one-credit requirement of EECS 601 for CSE Ph.D. students which will replace one of the credits associated with the EECS 699 research requirement.
    b. Students who enter the Ph.D. program, in either the Spring/Summer semesters or Winter term would take the class the following Fall term.
3. Joint CoE/LSA Curriculum Committee on April 4, 2023 from 3-5pm - Informational Item
    a. The LSA Curriculum Committee has sent over their list of names of the individuals to invite to the Joint CoE/LSA Curriculum Committee meeting. Their list of constituents to attend the meeting includes LSA Curriculum Committee members, various members of LSA leadership, as well as representatives from key LSA units (i.e. Math).
    b. A question of discussion for the CCC – Are there any additional constituents in CoE, outside of the CoE Curriculum Committee members, that we wish to invite to attend the Joint CoE/LSA Curriculum Committee meeting?
        i. Xiaogan suggested inviting the Undergraduate and Graduate Chairs within CoE Departments as well as the ADUE/ADGPE.
            1. It was decided after the meeting by the CCC Chair that only the ADUE & ADGPE would be invited at this time due to room capacity restraints.
        ii. CCC members may send an email to the CCC Chair and CCC Support Staff if suggestions arise.
    c. Topics for the CoE/LSA Joint Curriculum Committee Meeting
        i. HLC Annual Audit
        ii. The CoE Incomplete Grade Policy and Course Withdrawals

CARF SUMMARIES

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	APPROVED	NOTES & REVISIONS	TABLED
5	AEROSP	488	MOD	Changes to Course Description, Course Credit Type, Grading Basis, Course Components	FT 2023	B	CONDITIONAL APPROVAL	Edit to Supporting Statement to add the justification for the contact hours.	

								Remove the last sentence from the Supporting Statement. Edit Course Description to remove the phrase, "Transformational course on" and begin with, "Leading and managing"	
8	**MATH**	**506**	**MOD**	Removal of IOE as cross listed department	**FT 2023**	**No**	**APPROVED**	Cross-listed with IOE 506	
11	**MATH**	**623**	**MOD**	Removal of IOE as cross listed department	**FT 2023**	**No**	**APPROVED**	Cross-listed with IOE 623	

MEMORANDUM

TO: Xiaogan Liang, Chair, College of Engineering Curriculum Committee

FROM: Diann Brei, Chair Integrative Systems + Design
Todd Allen, Chair Nuclear Engineering and Radiological Sciences

DATE: February 9, 2023

RE: Request for Approval for Sequential Master of Engineering/B.S.E. Programs with Nuclear Engineering & Radiological Sciences

The Integrative Systems + Design (ISD) Division plans to admit Nuclear Engineering & Radiological Sciences undergraduate students with greater than 3.2 GPA as the Sequential Undergraduate/ Graduate Study (SUGS) students in the following five ISD Master of Engineering (MEng) programs:

- Automotive Engineering (AUTO)
- Energy Systems Engineering (ESE)
- Global Automotive and Manufacturing Engineering (GAME)
- Manufacturing (MFG)
- Systems Engineering + Design (SE+D)

ISD is seeking to expand SUGS partnerships with key College of Engineering departments. ISD currently has SUGS agreements with Material Science Engineering (MSE) and Mechanical Engineering (ME) for the above ISD programs and our Manufacturing program has SUGS with additional departments. These SUGS partnerships have been successful in increasing recruitment to our ISD master programs as well as providing useful advanced degrees for top CoE undergraduates. Since 2018, ISD typically admits about 17 SUGS students per academic year through SUGS partnerships with CoE departments. Our programs provide students with unique opportunities to maximize their educational experience, as the integrative mindset and systems thinking skills developed through ISD's curriculum pair well with the depth of department specializations.

Launching Fall 2022, ISD has introduced a new integrative curriculum designed to better meet today's industry demands and offer improved depth and breadth within specializations – all while leveraging U-M excellence across many disciplines. The curriculum is comprised of 4 segments:

- Integrative Science (6-9 credits): students integrate disciplines together by taking advantage of the breadth of U-M courses, including required ISD courses.
- Program Core (6-9 credits): these courses offer the core knowledge students need to excel in their chosen specialty by choosing courses across key foundational areas, each with their own set of key competencies.
- Career Pathways(9 credits): these courses are designed to help students gain expert knowledge in one specific knowledge area, strategically crafted by leading industry and government experts with an eye to their career trajectory.
- Immersive Practice (3-6 credits): students put their experience and education to work in a real-world environment by taking part in a culminating project in industry, research in cutting-edge labs, field-work with meaningful non-profits, and a wide range of entrepreneurial ventures.

This new curriculum framework provides even more opportunity for students in CoE departments to advance with a Master of Engineering degree.

For the SUGS between NERS and ISD, the template for SUGS programs as approved by the College of Engineering in 1996 and the revision of 1999 is followed. NERS undergraduate students who have completed 80 or more credits of course work should begin advising with an ISD graduate coordinator, and can apply to one of the five ISD

programs during the first term of their senior year. Applicants must meet ISD's application requirements, including academic statement of purpose, resume, personal statement, and 3 letters of recommendation, with a SUGS GPA requirement of 3.2.

Students must meet all requirements for both NERS BSE and ISD Master of Engineering degrees. The NERS undergraduate electives and technical electives at the 400-level which fulfill the undergraduate degree requirements can be "doubled counted" up to 9 credit hours in the curriculum of one of the five ISD programs as delineated in the appendixes. ISD allows a maximum of 15 credit hours taken outside the ISD MEng degree to count toward the MEng degree. This includes credits that are double counted (up to 9 hours), transferred from the U-M undergraduate program, and transferred from outside of U-M (up to 6 hours). All double-counted and transfer courses must have grades of "B" or above and be able to fit into the MEng degree requirements.

Each ISD MSE program has a faculty program director as well as a program committee that provides curriculum oversight as well as student support (recruitment, advising, mentoring, probation, petitions, etc). They along with ISD leadership (associate chairs and directors) and staff will provide the oversight for the ISD/NERS Sugs program. The SUGS curriculum will undergo review alongside the regular review cycle for each ISD programs, which include an annual review of courses and a deeper 3-year review of each program. Course modification and additions – updating, sunsetting and development – will go through our ISD course approval process and new courses can be double counted once approved through this ISD course approval process. ISD chair/associate chairs and ADGPE meet annual to review all programs. Note that no additional funding or resources are needed for the SUGS program, as both NERS and ISD have the necessary infrastructure and resources in place to support it.

Students should consult with NERS undergraduate advisor as well as the relevant ISD graduate coordinator and submit a SUGS/MEng Plan of Study, which lists courses that will be double-counted as well as the courses that are selected to fulfill curriculum requirements in an ISD program. Advising and degree audit processes for ISD MEng programs will be managed by ISD; advising and degree audit processes for NERS BSE will be managed by NERS. Should student progress in either degree require the discontinuation of the student from either degree, ISD and NERS will jointly manage processing and student communication.

The following pages include:

Appendix 1A, 2A, 3A, 4A, and 5A includes

- An overview of the curriculum for each of the five ISD Master of Engineering programs.
- List of ISD courses that NERS accepts for double counting to satisfy NERS BSE technical elective requirement.

Appendices 1B, 2B, 3B, 4B, and 5B include a sample BSE/Master of Engineering schedule with a complete sample plan of study for a SUGS student to fulfill all Nuclear Engineering & Radiological Sciences BSE and Master of Engineering degree requirements within a ten-term period.

- Courses are grouped by degree requirement.
- Double-counted courses are denoted as (D).
- Credit hours are shown by term and totaled for each degree requirement, each term, and for the overall degree.

Appendices by Program:

Appendix 1: (BSE) Nuclear Engineering & Radiological Sciences and Master of Engineering in Automotive Engineering

- Appendix 1A**:** Master of Engineering in Automotive Engineering Curriculum (AUTO)
- Appendix 1B: (BSE) Nuclear Engineering & Radiological Sciences / (AUTO) Master of Engineering in Automotive Engineering Sample Schedule

Appendix 2: (BSE) Nuclear Engineering & Radiological Sciences and Master of Engineering in Energy Systems Engineering

- Appendix 2A: Master of Engineering in Energy Systems Engineering Curriculum (ESE)
- Appendix 2B: (BSE) Nuclear Engineering & Radiological Sciences / (ESE) Master of Engineering in Energy Systems Engineering Sample Schedule

Appendix 3: (BSE) Nuclear Engineering & Radiological Sciences and Master of Engineering in Global Automotive and Manufacturing Engineering

- Appendix 3A: Master of Engineering in Global Automotive and Manufacturing Engineering Curriculum (GAME)
- Appendix 3B: (BSE) Nuclear Engineering & Radiological Sciences / (GAME) Master of Engineering in Global Automotive and Manufacturing Engineering Sample Schedule

Appendix 4: (BSE) Nuclear Engineering & Radiological Sciences and Master of Engineering in Manufacturing

- Appendix 4A: Master of Engineering in Manufacturing Curriculum (MFG)
- Appendix 4B: (BSE) Nuclear Engineering & Radiological Sciences / (MFG) Master of Engineering in Manufacturing Sample Schedule

Appendix 5: (BSE) Nuclear Engineering & Radiological Sciences and Master of Engineering in Systems Engineering + Design

- Appendix 5A: Master of Engineering in Systems Engineering + Design Curriculum (SE+D)
- Appendix 5B: (BSE) Nuclear Engineering & Radiological Sciences / (SE+D) Master of Engineering in Systems Engineering + Design Sample Schedule

Appendix 1A: Master of Engineering in Automotive Engineering Curriculum (AUTO)

ISD Courses Approved To Satisfy NERS BSE Technical Elective Requirement

The Master of Engineering in Automotive Engineering requires 30 credit-hours of coursework:

- At least 24 credit-hours must be letter-graded (A-E) coursework. (Check with specific program for any exceptions.)
- 503 Projects/Practicums are graded Satisfactory/Unsatisfactory
- At least 24 credit-hours must be in courses 500-level or above. (Check with specific program for any exceptions.)
- No more than 6 credit-hours can be transferred from another institution. (Required approval by program committee).
- A minimum grade point average of 3.0/4.0 (i.e., a "B" average) is required for graduation.
- Complete all of the courses on the approved POS within five years from the date of first enrollment

All ISD courses are approved to satisfy NERS BSE technical elective requirement. The following is a summary of the Master of Engineering in Automotive Engineering course requirements.

Integrative Science (6-9 credits)

Required Course	
AUTO 501	Integrated Vehicle Systems Design
Other Course Offerings	
Integrative Thinking	
DESCI 501	Analytical Product Design
DESCI 502	Design Process Models
ISD 520	Introduction to Systems Engineering
ISD 521	Development and Verification of System Design Requirements
ISD/MFG 527	Designing in Quality: A Design for Six Sigma
Model-Based Systems Engineering and Design	
ISD 522	Systems Engineering Architecture & Design
ISD/ESENG 532 (EAS 574/ PUBPOL 519)	Sustainable Energy Systems
ISD 599 (NAVARCH 515/ MECHENG 599)	Residual Stress and Distortion in Modern Manufacturing
ISD/MFG 555 (MECHENG 555)	Design Optimization
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
ISD 565 (MECHENG 565)	Battery Systems and Control
Global Engineering Leadership	
MFG 587 (MECHENG 587)	Global Manufacturing
Socio-Technology	
ESENG 567(CEE 567)	Energy Infrastructure Systems

Program Core (9 credits) (Select courses across topic areas)

Powertrain	
AUTO 533 (MECHENG 433	Advanced Energy Solutions
AUTO 563	Dynamics and Controls of Automatic Transmissions
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
ISD 599 (CHE 696)	Fuels Cells & Fuel Processors
ESENG 505 (MECHENG 571, CHE 696)	Energy Generation and Storage Using Modern Materials
ISD 599 (MECHENG 438)	Internal Combustion Engines
ISD 565 (MECHENG 565)	Battery Systems and Control
ISD 599 (MECHENG 569)	Control of Advanced Powertrain Systems
Vehicle Structure & Materials	
AUTO/MFG 513 (MECHENG 513)	Automotive Body Structures
AUTO/ISD 514	Vehicle Crashworthiness and Occupant Protection
ISD 599 (NAVARCH 515)	Residual Stress and Distortion in Modern Manufacturing
ISD 599 (MFG 599)	Foundations in Smart Additive Manufacturing
MFG 514 (MATSCIE 514)	Composite Materials
Vehicle Dynamics & Controls	
AUTO/MFG 513 (MECHENG 513)	Automotive Body Structures
AUTO 542 (MECHENG 542)	Vehicle Dynamics and Automation
AUTO 563	Dynamics and Control of Automatic Transmissions
AUTO/ISD 541	Fundamentals of Vehicle Dynamics
ISD 546 (MECHENG 545, CHE 577)	Dynamics and Control of Connected Vehicles
ISD 599 (MECHENG 569)	Control of Advanced Powertrain Systems
Vehicle Electrical & Software	
ISD 599 (EECS 419)	Electric Machinery and Drives

Career Pathways (9 credits) (Select courses within one topic area)

Automotive Powertrain & Electrification Systems Design	
AUTO 533 (MECHENG 433	Advanced Energy Solutions
AUTO 563	Dynamics and Controls of Automatic Transmissions
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
DESCI 501	Analytical Product Design
ESENG 505 (MECHENG 571, CHE 696)	Energy Generation and Storage Using Modern Materials
ISD 528 (MECHENG 542)	Advanced Design for Manufacturability
ISD 599 (EECS 419)	Electric Machinery and Drives
ISD 565 (MECHENG 565)	Battery Systems and Control
AUTO/ISD 541	Fundamentals of Vehicle Dynamics
ISD 599 (CHE 696)	Fuels Cells & Fuel Processors
ISD 599 (MECHENG 438)	Internal Combustion Engines
ISD 599 (MECHENG 569)	Control of Advanced Powertrain Systems

Autonomous & Connected Vehicle Design	
AUTO 542 (MECHENG 542)	Vehicle Dynamics and Automation
DESCI 501	Analytical Product Design
AUTO/ISD 541	Fundamentals of Vehicle Dynamics
ISD 599 (EECS 419)	Electric Machinery and Drives
ISD 546 (MECHENG 545, CHE 577)	Dynamics and Control of Connected Vehicles
Vehicle Dynamics & NVH (Noise, Vibration, & Harshness) Design	
DESCI 501	Analytical Product Design
DESCI 502	Design Process Models
ISD 522	Systems Engineering Architecture & Design
ISD 523 (IOE 561)	Risk Analysis I
ISD/MFG 527	Designing in Quality: A Design for Six Sigma
ISD 528/MFG 452 (MECHENG 452)	Advanced Design for Manufacturing
ISD/MFG 555 (MECHENG 555)	Design Optimization
AUTO/ISD 541	Fundamentals of Vehicle Dynamics
ISD 546 (MECHENG 545, CHE 577)	Dynamics and Control of Connected Vehicles
MFG 461 (IOE 461)	Quality Engineering Principles & Analysis
MFG 514 (MATSCIE 514)	Composite Materials
Vehicle Body, Interior & Safety Design	
AUTO/MFG 513 (MECHENG 513)	Automotive Body Structures
ISD 521	Development and Verification of System Design Requirements
ISD 522	Systems Engineering Architecture & Design
ISD 523 (IOE 561)	Risk Analysis I
ISD/MFG 527	Designing in Quality: A Design for Six Sigma
ISD 528 (MECHENG 542)	Advanced Design for Manufacturability
ISD/MFG 555 (MECHENG 555)	Design Optimization
AUTO/ISD 541	Fundamentals of Vehicle Dynamics
ISD 599 (MFG 599)	Foundations in Smart Additive Manufacturing
ISD 599 (NAVARCH 515)	Residual Stress and Distortion in Modern Manufacturing
MFG 461 (IOE 461)	Quality Engineering Principles & Analysis
MFG 514 (MATSCIE 514)	Composite Materials
MFG 588 (MECHENG 588)	Assembly Modeling for Design and Manufacturing
Vehicle Mobility Systems	
DESCI 501	Analytical Product Design
DESCI 502	Design Process Models
ISD/MFG 527	Designing in Quality: A Design for Six Sigma
ISD 599 (EECS 419)	Electric Machinery and Drives
Vehicle Human-Centered Design and Architecture	

AUTO/MFG 513 (MECHENG 513)	Automotive Body Structures
AUTO/ISD 514	Vehicle Crashworthiness and Occupant Protection
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
DESCI 501	Analytical Product Design
DESCI 502	Design Process Models
ISD/MFG 527	Designing in Quality: A Design for Six Sigma
ISD 528 (MECHENG 542)	Advanced Design for Manufacturability
ISD/MFG 555 (MECHENG 555)	Design Optimization
AUTO/ISD 541	Fundamentals of Vehicle Dynamics
ISD 599 (EECS 419)	Electric Machinery and Drives
MFG 461 (IOE 461)	Quality Engineering Principles & Analysis
ISD 523 (IOE 561)	Risk Analysis I
Motorsports Engineering	
AUTO 542 (MECHENG 542)	Vehicle Dynamics and Automation
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
ESENG 505 (MECHENG 571, CHE 696)	Energy Generation and Storage Using Modern Materials
ISD 599 (MECHENG 569)	Control of Advanced Powertrain Systems
ISD 599 (NAVARCH 515)	Residual Stress and Distortion in Modern Manufacturing
ISD 599 (MFG 599)	Smart Manufacturing Systems
AUTO/ISD 514	Vehicle Crashworthiness and Occupant Protection
ISD/MFG 555 (MECHENG 555)	Design Optimization
ISD 565 (MECHENG 565)	Battery Systems and Control
MFG 514 (MATSCIE 514)	Composite Materials

Immersive Practice - Seminar and Capstone Project (3-6 credits)

AUTO 503	Automotive Engineering Project

NERS BSE Courses Approved To Satisfy ISD Master of Engineering in Automotive Engineering

Integrative Science

Global Engineering Leadership	
NERS 531	Nuclear Waste Management

Appendix 1B: Sample Schedule (BSE) Nuclear Engineering & Radiological Sciences/ (AUTO) Master of Engineering in Automotive Engineering

A complete plan of study for a SUGS student to fulfill all (BSE) Nuclear Engineering & Radiological Sciences and Master of Engineering in Automotive Engineering degree requirements within a ten-term period. Courses are

grouped by degree requirement. Double-counted courses are denoted (DC). Credit hours are shown by term and totaled for each degree requirement, each term, and for the overall degree.

Sample Schedule B.S.E. (Nuclear Engineering & Radiological Sciences)/MEng (Automotive Engineering)												
BSE (Nuclear Engineering & Radiological Sciences)			**Undergraduate Terms**								**Graduate Terms**	
Course Number	**DC**	**Hrs.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Engineering Core (55 hrs.)												
MATH 115, 116, 215, and 216+		16	4	4	4	4						
ENGR 100		4	4									
ENGR 101		4		4								
CHE 125/126 and 130 or CHE 210 and 211		5	5									
Physics 140 with Lab 141; Physics 240 with Lab 241		10		5	5							
Intellectual Breadth		16	4	4	4			4				
Engineering Core Subtotal		55										
Related Technical Subjects(11 hrs.)												
MATSCIE 250, Princ of Eng Materials or MSE 220, Intro to Materials and Manf		4				4						
EECS 215, Intro to Circuits or EECS 314, Electrical Circuits, Systems, and Applications		4					4					
MECHENG 235, Thermodynamics I		3					3					
Related Program Subtotal		11										
Program Subjects (45 hrs.)												
NERS 250, Fundamentals of Nuclear Eng and Rad Sci		4				4						
NERS 311, Ele of Nuc Eng & Rad Sci I		3					3					
NERS 312, Ele of Nuc Eng & Rad Sci II		3						3				
NERS 315, Nuclear Instr Lab		4						4				
NERS 320, Prob in Nucl Engr & Rad Sci		4					4					
NERS 344, Fluid Mech Nucl Eng		3						3				
NERS 441, Nuclear Reactor Theory I		4							4			
NERS 444, Fundamentals of Heat and Mass Transfer		3							3			
Laboratory Course (above NERS 315)		4								4		
NERS 491, Nuclear Engineering and Radiological Sciences Design I		1							1			
NERS 492, Nuclear Engineering and Radiological Sciences Design II		3								3		
NERS Electives (**NERS electives are any NERS courses 400lvl+ that are not already required by the degree**)		9							6	3		
Core Subtotal		45										
Technical Electives (5 hours) **Technical electives are defined as 300-level and above Mathematics, Physics, or non-NERS Engineering courses. Course content must be technical. All substitutions must be approved by the faculty advisor.**												
ISD 520 Introduction to Systems Engineering	DC	3								3		
ISD/MFG 527: Designing in Quality: A Design for Six Sigma	DC	3								3		
		6										
General Electives (12 hours												
General Electives		12			3	3		3	3			
Electives Subtotal		12										
Total BSE Program Credits		129	17	17	16	15	14	17	17	16	0	0
MEng (Automotive Engineering Program)			**Undergraduate Terms**								**Graduate Terms**	
Course	**DC**	**Hrs.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Integrative Science (6-9 credits)												
AUTO 501 Integrated Vehicle Systems Design		3										3
ISD 520: Introduction to Systems Engineering	**DC**	3								3		
ISD/MFG 527: Designing in Quality: A Design for Six Sigma	**DC**	3								3		
Integrative Science Subtotal		9										
Program Core (9 credits)												
MECHENG 542: Vehicle Dynamics (Struct. & Dyn)		3								3		
AUTO/MECHENG 513: Auto. Body Struct. (Struct. & Dyn)		3									3	
AUTO 533: Advanced Energy Solutions (Powertrain)		3									3	

Program Core Subtotal		*9*										
Career Pathways (9 credits)												
AUTO/ISD 541 Fundamentals of Vehicle Dynamics		*3*									3	
AUTO/ISD 562: Modeling Analysis of Vehicle Systems		*3*							*3*			
MECHENG 541: Mechanical Vibrations (Noise, vib. Harsh.)		*3*										*3*
Career Pathways Subtotal		*9*										
Immersive Practice (3 credits)												
AUTO 503: Automotive Engineering Project		*3*										*3*
Immersive Practice Subtotal		*3*										
Total MEng Program Credits		***30***	***0***	***0***	***0***	***0***	***0***	***0***	***3***	***9***	***9***	***9***

Appendix 2A: Master of Engineering in Energy Systems Engineering Curriculum (ESE)

ISD Courses Approved To Satisfy NERS BSE Technical Elective Requirement

The Master of Engineering in Energy Systems Engineering requires 30 credit-hours of course work:

- At least 24 credit-hours must be letter-graded (A-E) coursework. (Check with specific program for any exceptions.)
- 503 Projects/Practicums are graded Satisfactory/Unsatisfactory
- At least 24 credit-hours must be in courses 500-level or above. (Check with specific program for any exceptions.)
- No more than 6 credit-hours can be transferred from another institution. (Required approval by program committee).
- A minimum grade point average of 3.0/4.0 (i.e., a "B" average) is required for graduation.
- Complete all of the courses on the approved POS within five years from the date of first enrollment

All ISD courses are approved to satisfy NERS BSE technical elective requirement. The following is a summary of the Master of Engineering in Energy Systems Engineering course requirements.

Integrative Science (9-12 credits)

Required Courses	
AUTO 533 (MECHENG 533)	Advanced Energy Systems
ESENG 505 (MECHENG 571, CHE 696)	Energy Generation and Storage Using Modern Materials
ESENG 501 (CEE 565)	Seminars on Energy Systems, Technology and Policy
Other Course Offerings	
Integrative Thinking	
DESCI 501	Analytical Product Design
DESCI 502	Design Process Models
ISD 520	Introduction to Systems Engineering
ISD 521	Development and Verification of System Design Requirements
ISD/MFG 527	Designing in Quality: A Design for Six Sigma
Model-Based Systems Engineering and Design	
ISD 522	Systems Engineering Architecture & Design
ISD/ESENG 532 (EAS 574/ PUBPOL 519)	Sustainable Energy Systems
ISD 599 (NAVARCH 515/ MECHENG 599)	Residual Stress and Distortion in Modern Manufacturing
ISD/MFG 555 (MECHENG 555)	Design Optimization
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
ISD 565 (MECHENG 565)	Battery Systems and Control
Global Engineering Leadership	
MFG 587 (MECHENG 587)	Global Manufacturing
Socio-Technology	

ESENG 567(CEE 567)	Energy Infrastructure Systems

Program Core (6 credits) (Select courses across topic areas)

Materials for Energy Solutions (MEMS)	
AUTO 533 (MECHENG 433	Advanced Energy Solutions
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
ESENG 505 (MECHENG 571, CHE 696)	Energy Generation and Storage Using Modern Materials
ESENG 567 (CEE 567)	Energy Infrastructure Systems
ISD 528 (MECHENG 452)	Advanced Design for Manufacturability
ESENG/ISD 532 (EAS 574)	Sustainable Energy Systems
ISD/ESENG 535 (CEE 564)	Greenhouse Gas Control
ISD 565 (MECHENG 565)	Battery Systems and Control
ISD 599 (EECS 419)	Electric Machinery and Drives
ISD 546 (MECHENG 545, CHE 577)	Dynamics and Control of Connected Vehicles
ISD 599 (CHE 696)	Fuel Cells & Fuel Processors
ISD 599 (EECS 414)	Introduction to MEMS
ISD 599 (EECS 434)	Principles of Photonics
ISD 599 (MECHENG 438)	Internal Combustion Engines
ISD 599 (MECHENG 589)	Sustainable Design of Technological Systems
Energy Technology Manufacturing (ETM)	
ESENG 505 (MECHENG 571, CHE 696)	Energy Generation and Storage Using Modern Materials
ESENG/ISD 532 (EAS 574)	Sustainable Energy Systems
ISD 565 (MECHENG 565)	Battery Systems and Control
ISD 599 (EECS 419)	Electric Machinery and Drives
ISD 599 (CHE 696)	Fuel Cells & Fuel Processors
ISD 599 (EECS 414)	Introduction to MEMS
ISD 599 (EECS 434)	Principles of Photonics
ISD 599 (MECHENG 438)	Internal Combustion Engines
ISD 599 (MECHENG 589)	Sustainable Design of Technological Systems
Energy Sustainability and Process (ESPS)	
AUTO 501	Integrated Vehicle Systems Design
AUTO 533 (MECHENG 433	Advanced Energy Solutions
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
ISD/ESENG 532 (EAS 574/ PUBPOL 519)	Sustainable Energy Systems
ESENG 501 (CEE 565)	Seminars on Energy Systems, Technology and Policy
ISD 520	Introduction to Systems Engineering
ISD 599 (CHE 696)	Fuel Cells & Fuel Processors
Energy Systems Platforms	
AUTO 533 (MECHENG 433	Advanced Energy Solutions

AUTO 563	Dynamics and Controls of Automatic Transmissions
ESENG 501 (CEE 565)	Seminars on Energy Systems, Technology and Policy
ISD 520	Introduction to Systems Engineering
ISD 521	Development and Verification of System Design Requirements
ISD 528 (MECHENG 452)	Advanced Design for Manufacturability
ISD/MFG 555 (MECHENG 555)	Design Optimization
ISD 599 (MECHENG 569)	Control of Advanced Powertrain Systems

Career Pathways (9 credits) (Select courses within one topic area)

Battery Science and Engineering	
AUTO 501	Integrated Vehicle Systems Design
ESENG 505 (MECHENG 571, CHE 696)	Energy Generation and Storage Using Modern Materials
ISD 565 (MECHENG 565)	Battery Systems and Control
ISD 599 (EECS 419)	Electric Machinery and Drives
ISD 546 (MECHENG 545, CHE 577)	Dynamics and Control of Connected Vehicles
ISD 599 (CHE 696)	Fuel Cells & Fuel Processors
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
Energy Generation, Distribution, and Usage	
AUTO 501	Integrated Vehicle Systems Design
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
ESENG 567 (CEE 567)	Energy Infrastructure Systems
ISD/MFG 555 (MECHENG 555)	Design Optimization
ISD 565 (MECHENG 565)	Battery Systems and Control
ISD 599 (EECS 419)	Electric Machinery and Drives
ISD 599 (CHE 696)	Fuel Cells & Fuel Processors
ISD 599 (MECHENG 489)	Sustainable Engineering & Design
ISD 599 (MECHENG 589)	Sustainable Design of Technological Systems
Transportation Power	
AUTO 501	Integrated Vehicle Systems Design
AUTO 563	Dynamics and Controls of Automatic Transmissions
ESENG 567 (CEE 567)	Energy Infrastructure Systems
ISD/MFG 555 (MECHENG 555)	Design Optimization
ISD 565 (MECHENG 565)	Battery Systems and Control
ISD 599 (EECS 419)	Electric Machinery and Drives
ISD 546 (MECHENG 545, CHE 577)	Dynamics and Control of Connected Vehicles
ISD 599 (MECHENG 438)	Internal Combustion Engines
ISD 599 (MECHENG 569)	Control of Advanced Powertrain Systems
Chemical Energy Conversion	
AUTO 501	Integrated Vehicle Systems Design
ISD/ESENG 532 (EAS 574/ PUBPOL 519)	Sustainable Energy Systems

ESENG 505 (MECHENG 571, CHE 696)	Energy Generation and Storage Using Modern Materials
ISD/ESENG 535 (CEE 564)	Greenhouse Gas Control
ISD/MFG 555 (MECHENG 555)	Design Optimization
ISD 599 (CHE 696)	Fuel Cells & Fuel Processors
ISD 599 (MECHENG 589)	Sustainable Design of Technological Systems
Environmental Stewardship of Energy Resources	
ISD/ESENG 532 (EAS 574/ PUBPOL 519)	Sustainable Energy Systems
ESENG 505 (MECHENG 571, CHE 696)	Energy Generation and Storage Using Modern Materials
ISD/ESENG 535 (CEE 564)	Greenhouse Gas Control
ISD 599 (CHE 696)	Fuel Cells & Fuel Processors
ISD 599 (MECHENG 589)	Sustainable Design of Technological Systems

Immersive Practice - Seminar and Capstone Project (3-6 credits)

ESENG 503	Energy Systems Engineering Project

NERS BSE Courses Approved To Satisfy ISD Master of Engineering in Energy Systems Engineering

Integrative Science

Global Engineering Leadership	
NERS 531	Nuclear Waste Management

Program Core

Materials for Energy Solutions (MEMS)	
NERS 421	Nuclear Engineering Materials
NERS 442	Nuclear Power Reactors
NERS 472	Fusion Reactor Technology
NERS 531	Nuclear Waste Management
NERS 543	Nuclear Reactor Theory II
NERS 551	Nuclear Reactor Kinetics
Energy Technology Manufacturing (ETM)	
NERS 442	Nuclear Power Reactors
NERS 512	Interaction of Radiation and Matter
NERS 524	Nuclear Fuels
NERS 531	Nuclear Waste Management
Energy Sustainability and Process (ESPS)	
NERS 462	Reactor Safety Analysis

Career Pathways (9 credits) (Select courses within one topic area)

Energy Generation, Distribution, and Usage	
NERS 421	Nuclear Engineering Materials

NERS 442	Nuclear Power Reactors
NERS 462	Reactor Safety Analysis
NERS 472	Fusion Reactor Technology
NERS 512	Interaction of Radiation and Matter
NERS 524	Nuclear Fuels
NERS 543	Nuclear Reactor Theory II
NERS 551	Nuclear Reactor Kinetics
Environmental Stewardship of Energy Resources	
NERS 531	Nuclear Waste Management

Appendix 2B. Sample Schedule (BSE) Nuclear Engineering & Radiological Sciences /(ESE) Master of Engineering in Energy Systems Engineering

The following table shows a complete plan of study for a SUGS student to fulfill all (BSE) Nuclear Engineering & Radiological Sciences BSE and Master of Engineering in Energy Systems Engineering degree requirements within a ten-term period. Courses are grouped by degree requirement. - Double-counted courses are denoted (DC). - Credit hours are shown by term and totaled for each degree requirement, each term, and for the overall degree.

Sample Schedule B.S.E. (Nuclear Engineering & Radiological Sciences)/MEng (Energy Systems Engineering)												
BSE (Nuclear Engineering & Radiological Sciences)			***Undergraduate Terms***								***Graduate Terms***	
Course Number	***DC***	***Hrs.***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Engineering Core (55 hrs.)												
MATH 115, 116, 215, and 216+		*16*	*4*	*4*	*4*	*4*						
ENGR 100		*4*	*4*									
ENGR 101		*4*		*4*								
CHE 125/126 and 130 or CHE 210 and 211		*5*	*5*									
Physics 140 with Lab 141; Physics 240 with Lab 241		*10*		*5*	*5*							
Intellectual Breadth		*16*	*4*	*4*	*4*			*4*				
Engineering Core Subtotal		*55*										
Related Technical Subjects(11 hrs.)												
MATSCIE 250, Princ of Eng Materials or MSE 220, Intro to Materials and Manf		*4*				*4*						
EECS 215, Intro to Circuits or EECS 314, Electrical Circuits, Systems, and Applications		*4*					4					
MECHENG 235, Thermodynamics I		*3*					*3*					
Related Program Subtotal		*11*										
Program Subjects (45 hrs.)												
NERS 250, Fundamentals of Nuclear Eng and Rad Sci		*4*				*4*						
NERS 311, Ele of Nuc Eng & Rad Sci I		*3*					*3*					
NERS 312, Ele of Nuc Eng & Rad Sci II		*3*						*3*				
NERS 315, Nuclear Instr Lab		*4*						*4*				
NERS 320, Prob in Nucl Engr & Rad Sci		*4*					*4*					
NERS 344, Fluid Mech Nucl Eng		*3*						3				
NERS 441, Nuclear Reactor Theory I		*4*							*4*			
NERS 444, Fundamentals of Heat and Mass Transfer		*3*							*3*			
Laboratory Course (above NERS 315		*4*								*4*		
NERS 491, Nuclear Engineering and Radiological Sciences Design I		*1*							*1*			
NERS 492, Nuclear Engineering and Radiological Sciences Design II		*3*								3		
NERS Electives (**NERS electives are any NERS courses 400lvl+ that are not already required by the degree**)		*9*							*6*	*3*		
Core Subtotal		*45*										
Technical Electives (5 hours) **Technical electives are defined as 300-level and above Mathematics, Physics, or non-NERS Engineering courses. Course content must be technical. All substitutions must be approved by the faculty advisor.**												
ESENG 505: Energy Generation and Storage Using Modern Materials	***DC***	*3*								*3*		
ESENG 501: Seminars on Energy Systems, Technology and Policy	***DC***	*3*								*3*		
		6										
General Electives (12 hours)												
General Electives		*12*			*3*	*3*		*3*	*3*			
Electives Subtotal		*12*										
Total BSE Program Credits		*129*	*17*	*17*	*16*	*15*	*14*	*17*	*17*	*16*	*0*	*0*
MEng (Energy Systems Engineering Program)			***Undergraduate Terms***								***Graduate Terms***	
Course	***DC***	***Hrs.***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Integrative Science (9-12 credits)												
AUTO 533: Advanced Energy Solutions (Powertrain)		*3*								*3*		

ESENG 505: Energy Generation and Storage Using Modern Materials	***DC***	*3*								*3*		
ESENG 501: Seminars on Energy Systems, Technology and Policy	***DC***	*3*								*3*		
ISD 565 (MECHENG 565): Battery Systems and Control		*3*							*3*			
Integrative Science Subtotal		*12*										
Program Core (6 credits)												
ESENG 599 (CEE 564): Greenhouse Gas Control		*3*									*3*	
EAS 574/PPOL 519: Sustainable Energy Systems		*3*										*3*
Program Core Subtotal		*6*										
Career Pathways (9 credits)												
AUTO 501: Integrated Vehicle Systems Design		*3*									*3*	
ENGR 521: Clean Technology Entrepreneurship		*3*								*3*		
ISD 520: Introduction to Systems Engineering		*3*										*3*
Career Pathways Subtotal		*9*										
Immersive Practice (3 credits)												
ESENG 503: Energy Systems Engineering Project		*3*										*3*
Seminars/Capstone Subtotal		*3*										
Total MEng Program Credits		***30***	***0***	***0***	***0***	***0***	***0***	***0***	***3***	***12***	***6***	***9***

Appendix 3A: Master of Engineering in Global Automotive and Manufacturing Engineering Curriculum (GAME)

ISD Courses Approved To Satisfy NERS BSE Technical Elective Requirement

The Master of Engineering in Global Automotive and Manufacturing Engineering requires 30 credit-hours of course work:

- At least 24 credit-hours must be letter-graded (A-E) coursework. (Check with specific program for any exceptions.)
- 503 Projects/Practicums are graded Satisfactory/Unsatisfactory
- At least 24 credit-hours must be in courses 500-level or above. (Check with specific program for any exceptions.)
- No more than 6 credit-hours can be transferred from another institution. (Required approval by program committee).
- A minimum grade point average of 3.0/4.0 (i.e., a "B" average) is required for graduation.
- Complete all of the courses on the approved POS within five years from the date of first enrollment

All ISD courses are approved to satisfy NERS BSE technical elective requirement. The following is a summary of the Master of Engineering in Global Automotive and Manufacturing Engineering course requirements.

Integrative Science (6-9 credits)

Required Courses (select one Systems and one Manufacturing)	
Systems Courses	
AUTO 501	Integrated Vehicle Systems Design
ISD 520	Introduction to Systems Engineering
Manufacturing Courses	
ISD/MFG 599 (MECHENG 599)	Smart Manufacturing Systems
MFG 587 (MECHENG 587)	Global Manufacturing
Other Course Offerings	
Integrative Thinking	
DESCI 501	Analytical Product Design
DESCI 502	Design Process Models
ISD 520	Introduction to Systems Engineering
ISD 521	Development and Verification of System Design Requirements
ISD/MFG 527	Designing in Quality: A Design for Six Sigma
Model-Based Systems Engineering and Design	
ISD 522	Systems Engineering Architecture & Design
ISD/ESENG 532 (EAS 574/ PUBPOL 519)	Sustainable Energy Systems
ISD 599 (NAVARCH 515/ MECHENG 599)	Residual Stress and Distortion in Modern Manufacturing
ISD/MFG 555 (MECHENG 555)	Design Optimization
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
ISD 565 (MECHENG 565)	Battery Systems and Control
Global Engineering Leadership	

MFG 587 (MECHENG 587)	Global Manufacturing
Socio-Technology	
ESENG 567(CEE 567)	Energy Infrastructure Systems

Program Core (9 credits) (Select courses across topic areas)

Auto-Body Materials	
ESENG 505 (MECHENG 571, CHE 696)	Energy Generation and Storage Using Modern Materials
ISD 599 (NAVARCH 515)	Residual Stress and Distortion in Modern Manufacturing
MFG 514 (MATSCIE 514)	Composite Materials
Automotive Structures	
AUTO/MFG 513 (MECHENG 513)	Automotive Body Structures
AUTO/ISD 514	Vehicle Crashworthiness and Occupant Protection
MFG 515 (NAVARCH 514)	Fatigue of Structures
Vehicle Manufacturing and Assembly	
AUTO/MFG 513 (MECHENG 513)	Automotive Body Structures
ISD 528 (MECHENG 452)	Advanced Design for Manufacturability
ISD/MFG 599 (MECHENG 599)	Foundations in Smart Additive Manufacturing
ISD/MFG 599 (MECHENG 599)	Smart Manufacturing Systems
ISD 599 (NAVARCH 515)	Residual Stress and Distortion in Modern Manufacturing
ISD 599 (MECHENG 589)	Sustainable Design of Technological Systems

Career Pathways (9 credits) (Select courses within one topic area)

Advanced Vehicle Manufacturing	
ISD/MFG 599 (MECHENG 599)	Smart Manufacturing Systems
ISD/MFG 599 (MECHENG 599)	Foundations in Smart Additive Manufacturing
ISD 599 (NAVARCH 515/ MECHENG 599)	Residual Stress and Distortion in Modern Manufacturing
ISD 599 (EECS 434)	Principles of Photonics
MFG 461 (IOE 461)	Quality Engineering Principles and Analysis
MFG 587 (MECHENG 587)	Global Manufacturing
MFG 588 (MECHENG 588, IOE 588)	Assembly Modeling for Design and Manufacturing
Advanced Automotive Structures	
AUTO/MFG 513 (MECHENG 513)	Automotive Body Structures
ISD 528 (MECHENG 542)	Advanced Design for Manufacturability
ISD 546 (MECHENG 545, CHE 577)	Dynamics and Control of Connected Vehicles
ISD 599 (NAVARCH 515/ MECHENG 599)	Residual Stress and Distortion in Modern Manufacturing
ISD 599 (EECS 414)	Introduction to MEMS

ISD 599 (MECHENG 489)	Sustainable Engineering & Design
MFG 515 (NAVARCH 514)	Fatigue of Structures
Electrification/Powertrain Integration and Manufacturing	
AUTO 533 (MECHENG 433	Advanced Energy Solutions
AUTO 563	Dynamics and Controls of Automatic Transmissions
ESENG 505 (MECHENG 571, CHE 696)	Energy Generation and Storage Using Modern Materials
ISD 528 (MECHENG 542)	Advanced Design for Manufacturability
ISD 565 (MECHENG 565)	Battery Systems and Control
ISD 599 (EECS 419)	Electric Machinery and Drives
ISD 599 (MECHENG 438)	Internal Combustion Engines
ISD 599 (CHE 696)	Fuel Cells & Fuel Processors
ISD 599 (MECHENG 569)	Control of Advanced Powertrain Systems
MFG 515 (NAVARCH 514)	Fatigue of Structures
MFG 588 (MECHENG 588, IOE 588)	Assembly Modeling for Design and Manufacturing
Global Supply Chain and Engineering Leadership	
MFG 587 (MECHENG 587)	Global Manufacturing

Immersive Practice - Seminar and Capstone Project (3-6 credits)

AUTO 503 or MFG 502	Automotive Engineering Project or Manufacturing Engineering Project

NERS BSE Courses Approved To Satisfy ISD Master of Engineering in Global Automotive and Manufacturing Engineering

Integrative Science

Global Engineering Leadership	
NERS 531	Nuclear Waste Management

Career Pathways (9 credits) (Select courses within one topic area)

Advanced Vehicle Manufacturing	
NERS 544	Monte Carlo Methods

Appendix 3B: Sample Schedule (BSE) Nuclear Engineering & Radiological Sciences /(GAME) Master of Engineering in Global Automotive and Manufacturing)

The following table shows a complete plan of study for a SUGS student to fulfill all (BSE) Nuclear Engineering & Radiological Sciences and Master of Engineering in Global Automotive and Manufacturing Engineering degree requirements within a ten-term period. Courses are grouped by degree requirement. Double-counted courses are denoted (DC). Credit hours are shown by term and totaled for each degree requirement, each term, and for the overall degree.

BSE (Nuclear Engineering & Radiological Sciences)			Undergraduate Terms								Graduate Terms	
Course Number	DC	Hrs.	1	2	3	4	5	6	7	8	9	10
Engineering Core (55 hrs.)												
MATH 115, 116, 215, and 216+		16	4	4	4	4						
ENGR 100		4	4									
ENGR 101		4		4								
CHE 125/126 and 130 or CHE 210 and 211		5	5									
Physics 140 with Lab 141; Physics 240 with Lab 241		10		5	5							
Intellectual Breadth		16	4	4	4	4		4				
Engineering Core Subtotal		55										
Related Technical Subjects(11 hrs.)												
MATSCIE 250, Princ of Eng Materials or MSE 220, Intro to Materials and Manf		4				4						
EECS 215, Intro to Circuits or EECS 314, Electrical Circuits, Systems, and Applications		4					4					
MECHENG 235, Thermodynamics I		3					3					
Related Program Subtotal		11										
Program Subjects (45 hrs.)												
NERS 250, Fundamentals of Nuclear Eng and Rad Sci		4				4						
NERS 311, Ele of Nuc Eng & Rad Sci I		3					3					
NERS 312, Ele of Nuc Eng & Rad Sci II		3						3				
NERS 315, Nuclear Instr Lab		4						4				
NERS 320, Prob in Nucl Engr & Rad Sci		4					4					
NERS 344, Fluid Mech Nucl Eng		3						3				
NERS 441, Nuclear Reactor Theory I		4							4			
NERS 444, Fundamentals of Heat and Mass Transfer		3							3			
Laboratory Course (above NERS 315		4								4		
NERS 491, Nuclear Engineering and Radiological Sciences Design I		1							1			
NERS 492, Nuclear Engineering and Radiological Sciences Design II		3								3		
NERS Electives (**NERS electives are any NERS courses 400lvl+ that are not already required by the degree**)		9							6	3		
Core Subtotal		45										
Technical Electives (5 hours) **Technical electives are defined as 300-level and above Mathematics, Physics, or non-NERS Engineering courses. Course content must be technical. All substitutions must be approved by the faculty advisor.**												
ISD 520: Introduction to Systems Engineering	DC	3								3		
ISD 599: Smart Manufacturing Systems	DC	3								3		
		6										
General Electives (12 hours)												
General Electives Electives		12			3	3		3	3			
Electives Subtotal		12										
Total BSE Program Credits		129	17	17	16	15	14	17	17	16	0	0

MEng (Global Automotive Manufacturing Engineering Program)			Undergraduate Terms								Graduate Terms	
Course	DC	Hrs.	1	2	3	4	5	6	7	8	9	10
Integrative Science (6-9 credits)												
ISD 520: Introduction to Systems Engineering	DC	3								3		3
ISD 599: Smart Manufacturing Systems	DC	3								3		
Integrative Science Subtotal		6										
Program Core (9 credits)												
MFG 461 (IOE 461) Quality Engineering Principles and Analysis		3									3	
ISD 599 (NAVARCH 515) Residual Stress and Distortion in Modern Manufacturing		3										3
MFG 514 (MATSCIE 514) Composite Materials		3								3		
Program Core Subtotal		9										
Career Pathways (9 credits)												
AUTO 533: Advanced Energy Solutions		3									3	
AUTO 563: Dynamics and Control of Automatic Transmissions		3								3		
ISD 528 (MECHENG 452) Advanced Design for Manufacturability		3										3

Career Pathways Subtotal		*9*										
Immersive Practice (3 credits)												
AUTO 503 or MFG 503: Automotive or Manufacturing Engineering Project		*3*										*3*
Seminars/Capstone Subtotal		*6*										
Total MEng Program Credits		***30***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***12***	***6***	***12***

Appendix 4A: Master of Engineering in Manufacturing (MFG)

ISD Courses Approved To Satisfy NERS BSE Technical Elective Requirement

The Master of Engineering in Manufacturing requires 30 credit-hours of course work:

- At least 24 credit-hours must be letter-graded (A-E) coursework. (Check with specific program for any exceptions.)
- 503 Projects/Practicums are graded Satisfactory/Unsatisfactory
- At least 24 credit-hours must be in courses 500-level or above. (Check with specific program for any exceptions.)
- No more than 6 credit-hours can be transferred from another institution. (Required approval by program committee).
- A minimum grade point average of 3.0/4.0 (i.e., a "B" average) is required for graduation.
- Complete all of the courses on the approved POS within five years from the date of first enrollment

All ISD courses are approved to satisfy NERS BSE technical elective requirements. The following is a summary of the Master of Engineering in Manufacturing course requirements.

Integrative Science (9-12 credits)

Required Course	
ISD/MFG 599 (MECHENG 599)	Smart Manufacturing Systems
Other Course Offerings	
Integrative Thinking	
DESCI 501	Analytical Product Design
DESCI 502	Design Process Models
ISD 520	Introduction to Systems Engineering
ISD 521	Development and Verification of System Design Requirements
ISD/MFG 527	Designing in Quality: A Design for Six Sigma
Model-Based Systems Engineering and Design	
ISD 522	Systems Engineering Architecture & Design
ISD/ESENG 532 (EAS 574/ PUBPOL 519)	Sustainable Energy Systems
ISD 599 (NAVARCH 515/ MECHENG 599)	Residual Stress and Distortion in Modern Manufacturing
ISD/MFG 555 (MECHENG 555)	Design Optimization
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
ISD 565 (MECHENG 565)	Battery Systems and Control
Global Engineering Leadership	
MFG 587 (MECHENG 587)	Global Manufacturing
Socio-Technology	
ESENG 567(CEE 567)	Energy Infrastructure Systems

Program Core (6 credits) (Select courses across topic areas)

Computational Methods and Simulation	
ISD 528 (MECHENG 452)	Advanced Design for Manufacturability

ISD/MFG 555 (MECHENG 555)	Design Optimization
ISD 599 (NAVARCH 515)	Residual Stresses and Distortions in Modern Manufacturing
MFG 588 (MECHENG 588)	Assembly Modeling for Design and Manufacturing
Automation and Process Control	
MFG 587 (MECHENG 587)	Global Manufacturing
MFG 588 (MECHENG 588)	Assembly Modeling for Design and Manufacturing
Supply Chain and Product Lifecycle Management	
ISD 599 (MECHENG 589)	Sustainable Design of Technological Systems
Sustainable Manufacturing & Circular Economy	
ISD/MFG 555 (MECHENG 555)	Design Optimization
ISD/MFG 599 (MECHENG 599)	Foundations in Smart Additive Manufacturing
ISD 599 (MECHENG 589)	Sustainable Design of Technological Systems

Career Pathways (9 credits) (Select courses within one topic area)

Additive Manufacturing	
ISD 528 (MECHENG 452)	Advanced Design for Manufacturability
ISD/MFG 555 (MECHENG 555)	Design Optimization
ISD/MFG 599 (MECHENG 599)	Foundations in Smart Additive Manufacturing
ISD 599 (MECHENG 589)	Sustainable Design of Technological Systems
MFG 514 (MATSCIE 514)	Composite Materials
Manufacturing Automation	
MFG 588 (MECHENG 588)	Assembly Modeling for Design and Manufacturing
Digital Manufacturing	
ISD 528 (MECHENG 452)	Advanced Design for Manufacturability
ISD/ESENG 535 (CEE 564)	Greenhouse Gas Control
ISD/MFG 555 (MECHENG 555)	Design Optimization
ISD 599 (NAVARCH 515)	Residual Stresses and Distortions in Modern Manufacturing
ISD 599 (MECHENG 589)	Sustainable Design of Technological Systems
MFG 587 (MECHENG 587)	Global Manufacturing
MFG 588 (MECHENG 588)	Assembly Modeling for Design and Manufacturing
Production Systems and Quality Engineering	
ISD 523 (IOE 561)	Risk Analysis
ISD/MFG 527	Designing in Quality A Design for Six Sigma
MFG 461 (IOE 461)	Quality Engineering Principles and Analysis
MFG 587 (MECHENG 587)	Global Manufacturing
Smart Manufacturing	

MFG 588 (MECHENG 588)	Assembly Modeling for Design and Manufacturing

Immersive Practice - Seminar and Capstone Project (3-6 credits)

ESENG 503	Energy Systems Engineering Project

NERS BSE Courses Approved To Satisfy ISD Master of Engineering in Manufacturing

Integrative Science

Global Engineering Leadership	
NERS 531	Nuclear Waste Management

Program Core

Computational Methods and Simulation	
NERS 544	Monte Carlo Methods
NERS 547	Computational Fluid Dynamics for Industrial Applications
NERS 570	Methods and Practice of Scientific Computing
NERS 531	Nuclear Waste Management

Appendix 4B. Sample Schedule (BSE) Nuclear Engineering & Radiological Sciences /(ESE) Master of Engineering Manufacturing

The following table shows a complete plan of study for a SUGS student to fulfill all (BSE) Nuclear Engineering & Radiological Sciences BSE and Master of Engineering in Manufacturing degree requirements within a ten-term period. Courses are grouped by degree requirement. - Double-counted courses are denoted (DC). Credit hours are shown by term and totaled for each degree requirement, each term, and for the overall degree.

Sample Schedule B.S.E. (Nuclear Engineering & Radiological Sciences)/MEng (Manufacturing)												
BSE (Nuclear Engineering & Radiological Sciences)			***Undergraduate Terms***								***Graduate Terms***	
Course Number	***DC***	***Hrs.***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Engineering Core (55 hrs.)												
MATH 115, 116, 215, and 216+		*16*	*4*	*4*	*4*	*4*						
ENGR 100		*4*	*4*									
ENGR 101		*4*		*4*								
CHE 125/126 and 130 or CHE 210 and 211		*5*	*5*									
Physics 140 with Lab 141; Physics 240 with Lab 241		*10*		*5*	*5*							
Intellectual Breadth		*16*	*4*	*4*	*4*			*4*				
Engineering Core Subtotal		*55*										
Related Technical Subjects(11 hrs.)												
MATSCIE 250, Princ of Eng Materials or MSE 220, Intro to Materials and Manf		*4*				*4*						
EECS 215, Intro to Circuits or EECS 314, Electrical Circuits, Systems, and Applications		*4*					*4*					
MECHENG 235, Thermodynamics I		*3*					*3*					
Related Program Subtotal		*11*										
Program Subjects (45 hrs.)												
NERS 250, Fundamentals of Nuclear Eng and Rad Sci		*4*				*4*						
NERS 311, Ele of Nuc Eng & Rad Sci I		*3*					*3*					
NERS 312, Ele of Nuc Eng & Rad Sci II		*3*						*3*				
NERS 315, Nuclear Instr Lab		*4*						*4*				
NERS 320, Prob in Nucl Engr & Rad Sci		*4*					*4*					
NERS 344, Fluid Mech Nucl Eng		*3*						*3*				
NERS 441, Nuclear Reactor Theory I		*4*							*4*			
NERS 444, Fundamentals of Heat and Mass Transfer		*3*							*3*			
Laboratory Course (above NERS 315		*4*								*4*		
NERS 491, Nuclear Engineering and Radiological Sciences Design I		*1*							*1*			
NERS 492, Nuclear Engineering and Radiological Sciences Design II		*3*								*3*		
NERS Electives (**NERS electives are any NERS courses 400lvl+ that are not already required by the degree**)		*9*							*6*	*3*		
Core Subtotal		*45*										
Technical Electives (5 hours) **Technical electives are defined as 300-level and above Mathematics, Physics, or non-NERS Engineering courses. Course content must be technical. All substitutions must be approved by the faculty advisor.**												
ISD 521: Development and Verification of System Design Requirements	***DC***	*3*								*3*		
ISD 522: Systems Engineering Architecture and Design	***DC***	*3*								*3*		
		6										
General Electives (12 hours)												
General Electives		*12*			*3*	*3*		*3*	*3*			
Electives Subtotal		*12*										
Total BSE Program Credits		*129*	*17*	*17*	*16*	*15*	*14*	*17*	*17*	*16*	*0*	*0*
MEng (Manufacturing)			***Undergraduate Terms***								***Graduate Terms***	
Course	***DC***	***Hrs.***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Integrative Science (9-12 credits)												
ISD 520: Introduction to Systems Engineering		*3*								*3*		

ISD 521: Development and Verification of System Design Requirements	***DC***	*3*					*3*			*3*		
ISD 522: Systems Engineering Architecture and Design	***DC***	*3*								*3*		
ISD 599: Smart Manufacturing Systems		*3*							*3*			
Integrative Science Subtotal		*12*										
Program Core (6 credits)												
ISD 528: Advanced Design for Manufacturability		*3*									*3*	
ISD 555: Design Optimization		*3*										*3*
Program Core Subtotal		*9*										
Career Pathways (9 credits)												
ISD 599: Foundations in Smart Additive Manufacturing		*3*									*3*	
ISD 599: Sustainable Design of Technological Systems		*3*								*3*		
MFG 514: Composite Materials		*3*										*3*
Career Pathways Subtotal		*9*										
Immersive Practice (3 credits)												
MFG 503: Manufacturing Project		*3*										*3*
Seminars/Capstone Subtotal		*6*										
Total MEng Program Credits		***30***	***0***	***0***	***0***	***0***	***0***	***0***	***3***	***12***	***6***	***9***

Appendix 5A: Master of Engineering in Systems Engineering + Design Curriculum (SE+D)

ISD Courses Approved To Satisfy NERS BSE Technical Elective Requirement

The Systems Engineering and Design MEng degree requires 30 credit hours of course work with:

- At least 24 credit-hours must be letter-graded (A-E) coursework. (Check with specific program for any exceptions.)
- 503 Projects/Practicums are graded Satisfactory/Unsatisfactory
- At least 24 credit-hours must be in courses 500-level or above. (Check with specific program for any exceptions.)
- No more than 6 credit-hours can be transferred from another institution. (Required approval by program committee).
- A minimum grade point average of 3.0/4.0 (i.e., a "B" average) is required for graduation.
- Complete all of the courses on the approved POS within five years from the date of first enrollment

All ISD courses are approved to satisfy NERS BSE technical elective requirement. The following is a summary of the Master of Engineering in Systems Engineering + Design course requirements.

Integrative Science (6-9 credits)

Required Courses	
ISD 520	Introduction to Systems Engineering
ISD 521	Development and Verification of System Design Requirements
ISD 522	Systems Engineering Architecture & Design
Other Course Offerings	
Integrative Thinking	
DESCI 501	Analytical Product Design
DESCI 502	Design Process Models
ISD 520	Introduction to Systems Engineering
ISD 521	Development and Verification of System Design Requirements
ISD/MFG 527	Designing in Quality: A Design for Six Sigma
Model-Based Systems Engineering and Design	
ISD 522	Systems Engineering Architecture & Design
ISD/ESENG 532 (EAS 574/ PUBPOL 519)	Sustainable Energy Systems
ISD 599 (NAVARCH 515/ MECHENG 599)	Residual Stress and Distortion in Modern Manufacturing
ISD/MFG 555 (MECHENG 555)	Design Optimization
AUTO 566 (MECHENG 566)	Modeling Analysis and Control of Hybrid Electric Vehicles
ISD 565 (MECHENG 565)	Battery Systems and Control
Global Engineering Leadership	
MFG 587 (MECHENG 587)	Global Manufacturing
Socio-Technology	
ESENG 567(CEE 567)	Energy Infrastructure Systems

Program Core (9-12 credits) (Select courses across topic areas)

Systems Analysis	
ISD/MFG 555 (MECHENG 555)	Design Optimization
Test and Evaluation	
ISD 523 (IOE 561)	Risk Analysis I
ISD/MFG 527	Designing in Quality: A Design for Six Sigma
MFG 461 (IOE 461)	Quality Engineering Principles & Analysis

Career Pathways (9 credits) (Select courses within one topic area)

Design Engineering	
DESCI 501	Analytical Product Design
ISD 528 (MECHENG 542)	Advanced Design for Manufacturability
Risk and Decision Management	
ISD/MFG 527	Designing in Quality: A Design for Six Sigma
ISD/MFG 555 (MECHENG 555)	Design Optimization
MFG 461 (IOE 461)	Quality Engineering Principles & Analysis
Smart Civil Infrastructure	
ISD 523 (IOE 561)	Risk Analysis I
Integrated Mobility Systems	
DESCI 501	Analytical Product Design
DESCI 502	Design Process Models
ISD 520	Introduction to Systems Engineering
ISD 521	Development and Verification of System Design Requirements
ISD 522	Systems Engineering Architecture & Design
ISD 523 (IOE 561)	Risk Analysis I
ISD/MFG 527	Designing in Quality: A Design for Six Sigma

Immersive Practice - Seminar and Capstone Project (3-6 credits)

ISD 503	ISD Practicum Project

NERS BSE Courses Approved To Satisfy ISD Master of Engineering in Systems Engineering + Design

Integrative Science

Global Engineering Leadership	
NERS 531	Nuclear Waste Management

Program Core (9-12 credits) (Select courses across topic areas)

Systems Analysis	
NERS 544	Monte Carlo Methods
NERS 561	Nuclear Core Design and Analysis I
NERS 570	Methods and Practice of Scientific Computing
NERS 644	Transport Theory

Test and Evaluation	
NERS 515	Nuclear Measurements Laboratory

Career Pathways (9 credits) (Select courses within one topic area)

Risk and Decision Management	
NERS 462	Reactor Safety Analysis

Appendix 5B: Sample Schedule (BSE) Nuclear Engineering & Radiological Sciences/(SE+D) Master of Engineering in Systems Engineering + Design

The following table shows a complete plan of study for a SUGS student to fulfill all (BSE) Nuclear Engineering & Radiological Sciences and Master of Engineering in Systems Engineering + Design degree requirements within a ten-term period. Courses are grouped by degree requirement. Double-counted courses are denoted (DC). Credit hours are shown by term and totaled for each degree requirement, each term, and for the overall degree.

Sample Schedule B.S.E. (Nuclear Engineering & Radiological Sciences)/MEng (Systems Engineering and Design)												
BSE (Nuclear Engineering & Radiological Sciences)			***Undergraduate Terms***								***Graduate Terms***	
Course Number	***DC***	***Hrs.***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Engineering Core (55 hrs.)												
MATH 115, 116, 215, and 216+		*16*	*4*	*4*	*4*	*4*						
ENGR 100		*4*	*4*									
ENGR 101		*4*		*4*								
CHE 125/126 and 130 or CHE 210 and 211		*5*	*5*									
Physics 140 with Lab 141; Physics 240 with Lab 241		*10*		*5*	*5*							
Intellectual Breadth		*16*	*4*	*4*	*4*	*4*		*4*				
Engineering Core Subtotal		*55*										
Related Technical Subjects(11 hrs.)												
MATSCIE 250, Princ of Eng Materials or MSE 220, Intro to Materials and Manf		*4*				*4*						
EECS 215, Intro to Circuits or EECS 314, Electrical Circuits, Systems, and Applications		*4*					4					
MECHENG 235, Thermodynamics I		*3*					*3*					
Related Program Subtotal		*14*										
Program Subjects (45 hrs.)												
NERS 250, Fundamentals of Nuclear Eng and Rad Sci		*4*				*4*						
NERS 311, Ele of Nuc Eng & Rad Sci I		*3*					*3*					
NERS 312, Ele of Nuc Eng & Rad Sci II		*3*						*3*				
NERS 315, Nuclear Instr Lab		*4*						*4*				
NERS 320, Prob in Nucl Engr & Rad Sci		*4*					*4*					
NERS 344, Fluid Mech Nucl Eng		*3*						3				
NERS 441, Nuclear Reactor Theory I		*4*							*4*			
NERS 444, Fundamentals of Heat and Mass Transfer		*3*							*3*			
Laboratory Course (above NERS 315		*4*								*4*		
NERS 491, Nuclear Engineering and Radiological Sciences Design I		*1*							*1*			
NERS 492, Nuclear Engineering and Radiological Sciences Design II		*3*								3		
NERS Electives (**NERS electives are any NERS courses 400lvl+ that are not already required by the degree**)		*9*							*6*	*3*		
MS&E Core Subtotal		*47*										
Technical Electives (5 hours) **Technical electives are defined as 300-level and above Mathematics, Physics, or non-NERS Engineering courses. Course content must be technical. All substitutions must be approved by the faculty advisor.**												
ISD 520: Introduction to Systems Engineering	***DC***	*3*								*3*		
ISD 599: Smart Manufacturing Systems	***DC***	*3*								*3*		
General Electives (12 hours)												
General Electives		*12*			*3*	*3*		*3*	*3*			
Electives Subtotal		*12*										
Total BSE Program Credits		*129*	*17*	*17*	*16*	*15*	*14*	*17*	*17*	*16*	*0*	*0*
MEng (Systems Engineering and Design)			***Undergraduate Terms***								***Graduate Terms***	
Course	***DC***	***Hrs.***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Integrative Science (9-12 credits)												
ISD 520: Introduction to Systems Engineering	***DC***	*3*								*3*		

ISD 521: Development and Verification of System Design Requirements		*3*							*3*			*3*
ISD 522: Systems Engineering Architecture and Design		*3*										
ISD 599: Smart Manufacturing Systems	***DC***	*3*								*3*		
Integrative Science Subtotal		*12*										
Program Core (6 credits)												
ISD 523 (IOE 561) Risk Analysis I		*3*									*3*	
EECS 561 Design of Digital Control Systems		*3*										*3*
Program Core Subtotal		*6*										
Career Pathways (9 credits)												
ISD/MFG 527: Designing in Quality: A Design for Six Sigma		*3*									*3*	
ISD 555 Design Optimization		*3*								*3*		
MFG 461 (IOE 461) Quality Engineering Principles and Analysis		*3*										*3*
Career Pathways Subtotal		*9*										
Immersive Practice (3 credits)												
ISD 503: Engineering Project		*3*										*3*
Seminars/Capstone Subtotal		*6*										
Total MEng Program Credits		***30***	***0***	***0***	***0***	***0***	***0***	***0***	***3***	***9***	***6***	***12***

Diann Brei
Professor and Chair, Integrative Systems and Design
Professor, Mechanical Engineering
University of Michigan

February 5, 2023

Xiaogan Liang
Chair, College of Engineering Curriculum Committee

Subject: Integrative Systems and Design (ISD) Division Support for the proposed Sequential Master of Engineering/ B.S.E Program with Nuclear Engineering and Radiological Sciences (NERS)

Dear Prof. Liang:

I am pleased to provide the full support of the Integrative Systems and Design Division for the formation of Sequential Master of Engineering/B.S.E. Programs with Nuclear Engineering & Radiological Sciences (NERS) undergraduate degree and Integrative Systems and Design Master Programs. The proposed SUGS has been developed in collaboration and has been unanimously voted to approve by ISD's faculty and leadership committees in January 2023 according to our standard review and approval process.

This partnership will provide students with unique learning opportunities, pairing the development of an integrative mindset and systems thinking offered by ISD with the depth of specialized knowledge offered through the NERS department.

We encourage your committee to approve this new program.

Sincerely,

Diann Brei

Diann Brei, Phd
Professor and Chair, Integrative Systems and Design
Professor, Mechanical Engineering
University of Michigan

COLLEGE OF ENGINEERING
NUCLEAR ENGINEERING & RADIOLOGICAL SCIENCES
UNIVERSITY OF MICHIGAN

Todd Allen
Glenn F. and Gladys H. Knoll Department Chair
3001 Michigan Memorial Phoenix Laboratory
2301 Bonisteel Boulevard *734-647-5845*
Ann Arbor, MI 48109-2104 *traumich@umich.edu*

4 February 2023

Xiaogan Liang
Chair, College of Engineering Curriculum Committee

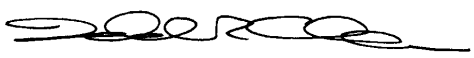
Subject: Nuclear Engineering & Radiological Sciences support for the proposed Sequential Master of Engineering/B.S.E. Program in Integrated Systems and Design

Dear Professor Liang:

The Department of Nuclear Engineering & Radiological Sciences faculty unanimously voted to approve support for the creation of a program to allow our students to pursue a sequential Master of Engineering/B.S.E. Programs with Integrated Systems and Design.

We think this is an excellent opportunity for our students and encourage your committee to approve this new program.

Sincerely,



Todd Allen
Glenn F. and Gladys H. Knoll Department Chair, Department of Nuclear Engineering & Radiological Sciences, University of Michigan

MICHIGAN ENGINEERING
UNIVERSITY OF MICHIGAN

Lola Eniola-Adefeso, Ph.D.
Associate Dean for Graduate & Professional Education
Professor of Chemical Engineering, Biomedical Engineering,
Macromolecular Science and Engineering

February 9, 2023

Dear Colleagues;

On behalf of Michigan Engineering and as Associate Dean for Graduate and Professional Education, I am pleased to provide this letter of support for the proposed request to admit Nuclear Engineering & Radiological Sciences (NERS) undergraduate student applicants as Sequential Undergraduate/ Graduate Study (SUGS) students in the following ISD Master of Engineering (MEng) and Master of Science programs: Automotive Engineering (AUTO); Energy Systems Engineering (ESE); Global Automotive and Manufacturing Engineering (GAME); Manufacturing (MFG); and Systems Engineering + Design (SE+D).

SUGS programs offer our most promising students the opportunity to complete Master's degree requirements as part of a seamless program combined with their undergraduate study at Michigan Engineering. Participating students in your programs will earn their Bachelor of Science in NERS and a Master's degree in one of the ISD programs listed above upon completing five years of study. Students must meet all requirements for both NERS BSE and ISD Master of Engineering / Master of Science degrees. The NERS undergraduate electives and technical electives at the 400-level, which fulfill the undergraduate degree requirements, can be "doubled counted" up to 9 credit hours in the curriculum of one of the five ISD programs.

We commend ISD for seeking to expand SUGS partnerships with key CoE departments and building upon the successful SUGS agreements currently in place with Material Science Engineering (MSE) and Mechanical Engineering (ME) for the above ISD programs in addition to your Manufacturing program that has SUGS agreements with additional departments. We hope that this new SUGS partnership with NERS will be successful in increasing recruitment to your ISD Master's programs as well as providing useful advanced degrees for top NERS undergraduates. We are hoping to grow the diversity in our CoE Master's programs. New SUGS programs such as these can be a valuable tool toward achieving that important and timely goal.

We applaud ISD for recently introducing a new integrative curriculum designed to better meet today's industry demands and offer improved depth and breadth within specializations. It is particularly noteworthy that this new curriculum framework provides increased opportunities for students in CoE departments such as NERS to advance with a Master's degree.

I look forward to the success of these exciting new programs.

Sincerely,

Lola Eniola-Adefeso, Ph.D. (Fellow of AIMBE, BMES)
Associate Dean for Graduate & Professional Education
University Diversity and Social Transformation Professor of Chemical Engineering;
Biomedical Engineering; Macromolecular Science and Engineering
Director, Cell Adhesion and Drug Delivery Lab
Associate Director, NIH Cellular Biotechnology Training Grant
Deputy Editor for Science Advance

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COLLEGE OF ENGINEERING
ELECTRICAL ENGINEERING & COMPUTER SCIENCE
UNIVERSITY OF MICHIGAN

November 29, 2022

College of Engineering Curriculum Committee
Re: Request to create new CSE and ECE subject codes

Dear College of Engineering Curriculum Committee:

The Electrical Engineering and Computer Science (EECS) department is requesting the creation of new CSE and ECE subject codes. While the department is comprised of two large divisions, Electrical and Computer Engineering (ECE) and Computer Science and Engineering (CSE), all classes in the EECS department currently share the same EECS designation. The sharing presents a few challenges: 1) it can be difficult for students to know if they are taking a CSE or an ECE course, which is relevant to whether or not the course counts as a program requirement; and 2) it effectively halves the numbers available for courses in either division. These issues are particularly acute at the graduate level, where the programs in the two divisions are largely distinct and we are running out of available course numbers at the 500 level.

The ECE and CSE divisions are proposing two new designations: CSE and ECE. The two divisions have agreed to the following plan to recategorize 500-level and higher EECS courses:

- New ‘ECE’ and ‘CSE’ categorizations will be created. The ‘EECS’ category will be kept.
- “Joint” courses (i.e., courses that have been listed by both graduate programs as satisfying degree requirements in both divisions) will remain in the ‘EECS’ category
- The remaining courses will be moved into the new ‘CSE’ and ‘ECE’ categories based upon which division ‘owns’ (i.e., is responsible for teaching) the course.
- Directed studies and special topics courses will be designated ‘ECE’ or ‘CSE’ depending upon the tenure home of the associated faculty member, or the appointment home for other lecturers.

The specific recategorization of courses is provided in the attached spreadsheet.

This new structure was approved by the ECE faculty on August 25, 2021 and by the CSE faculty on September 21, 2021. We are requesting that the CoE Curriculum Committee approve this plan, along with the creation of the new subject codes.

Thank you for considering these changes. Please let us know if you have any questions.

Sincerely,

Emily Mower Provost
Associate Chair for Graduate Affairs, CSE

Associate Professor of Electrical Engineering and Computer Science
University of Michigan

Heath Hofmann
Associate Chair of ECE Graduate Affairs
Professor of Electrical Engineering and Computer Science
University of Michigan

Course	CSE Desig.	ECE Desig.
EECS 500 Tutorl Sys Sci		ECE 500
EECS 501 Probability and Random Processes		ECE 501
EECS 502 Stochastic Processes		ECE 502
EECS 503 Intro. to Numerical Electromag.		ECE 503
EECS 505 Computational Data Science and Machine Learning		ECE 505
EECS 506 Design of Power Electronics		ECE 506
EECS 508 Control and Modeling of Power Electronics		ECE 508
EECS 509 BIOMEMS		ECE 509
EECS 510 RF MEMS		ECE 510
EECS 511 Integrated Analog/Digital Interface Circuits		ECE 511
EECS 512 Amorphous and Microcryst. Semic. Thin Film Devices		ECE 512
EECS 513 Flat Panel Displays		ECE 513
EECS 514 Advanced MEMS		ECE 514
EECS 515 Integ Microsystems		ECE 515
EECS 516 Medical Imaging Systems		ECE 516
EECS 517 Physical Processes in Plasmas		ECE 517
EECS 518 Magnetosphere and Solar Wind		ECE 518
EECS 519 Plasma Generation and Diagnostics Lab.		ECE 519
EECS 520 Elect Opt Semicon		ECE 520
EECS 521 High-Speed Transistors		ECE 521
EECS 524 Organic Electronic Devices and Applications		ECE 524
EECS 525 Adv Sol St Mw Cir		ECE 525
EECS 526 Plasmonics		ECE 526
EECS 528 M-Elec Proc Tech		ECE 528
EECS 529 Semiconductor Lasers and LEDs		ECE 529
EECS 530 Electromagnetic Theory I		ECE 530
EECS 531 Antenna Theory and Design		ECE 531
EECS 532 Microwave Remote Sensing I		ECE 532
EECS 533 Microwave Measurements Lab.		ECE 533
EECS 534 Design and Char. of Microw. Dev. and Monolithic Circuits		ECE 534
EECS 535 Optical Inf. Processing		ECE 535
EECS 536 Classical Statistical Optics		ECE 536
EECS 537 Classical Optics		ECE 537
EECS 538 Optical Waves in Crystals		ECE 538
EECS 539 Lasers		ECE 539
EECS 540 Applied Quantam Mechanics I		ECE 540
EECS 541 Applied Quantam Mechanics II		ECE 541
EECS 544 Analys Soc Networks		ECE 544
EECS 546 Ultrafast Optics		ECE 546
EECS 547 Incentives and Strategic Behavior in Computational Systems	CSE 547	
EECS 548 Information Visualization	CSE 548	
EECS 549 Information Retrieval	CSE 549	

EECS 550 Information Theory		ECE 550
EECS 551 Math Meth Sig Proc		ECE 551
EECS 552 Fiber Optical Comm.		ECE 552
EECS 554 Intro to Digital Communication and Coding		ECE 554
EECS 555 Digital Comm. Theory		ECE 555
EECS 556 Image Processing		ECE 556
EECS 557 Comm. Networks		ECE 557
EECS 558 Stochastic Control		ECE 558
EECS 559 Adv. Signal Processing		ECE 559
EECS 560 Linear Systems Theory		ECE 560
EECS 561 Design of Digital Control Systems		ECE 561
EECS 562 Nonlinear Systems and Control		ECE 562
EECS 563 Hybrid Control		ECE 563
EECS 564 Estimation, Filering, and Detection		ECE 564
EECS 565 Linear Feedback Control Systems		ECE 565
EECS 566 Discrete Event Syst		ECE 566
EECS 569 Production Systems Engineering		ECE 569
EECS 572 Randomness and Comp	CSE 572	
EECS 574 Computational Complexity	CSE 574	
EECS 575 Advanced Cryptography	CSE 575	
EECS 576 Advanced Data Mining	CSE 576	
EECS 582 Advanced Operating Systems	CSE 582	
EECS 583 Advanced Compilers	CSE 583	
EECS 584 Advanced Database Systems	CSE 584	
EECS 586 Design and Analysis of Algorithms	CSE 586	
EECS 587 Parallel Computing	CSE 587	
EECS 588 Computer and Network Security	CSE 588	
EECS 589 Advanced Computer Networks	CSE 589	
EECS 590 Advanced Programming Languages	CSE 590	
EECS 591 Distributed Systems	CSE 591	
EECS 592 Foundations of Artificial Intelligence	CSE 592	
EECS 593 Human-Computer Interaction	CSE 593	
EECS 595 Natural Language Processing	CSE 595	
EECS 596 Master of Engineering Team Project		ECE 596
EECS 597 Language and Information	CSE 597	
EECS 598 Special Topics	CSE 598	ECE 598
EECS 599 Directed Study	CSE 599	ECE 599
EECS 600 Function Space Methods in System Theory		ECE 600
EECS 601 Intro CSE Grad Res	CSE 601	
EECS 602 Reinforcement Learning Theory		ECE 602
EECS 605 Data Science and Machine Learning Design Laboratory		ECE 605
EECS 620 Autonomous Robotics		ECE 620
EECS 631 Electromagnetic Scattering		ECE 631

EECS 633 Numerical Methods in Electromagnetics		ECE 633
EECS 634 Nonlinera Optics		ECE 634
EECS 638 Quantum Theory of Light		ECE 638
EECS 643 Theory of Neural Computation	CSE 643	
EECS 644 Computational Modeling of Cognition	CSE 644	
EECS 650 Channel Coding Theory		ECE 650
EECS 659 Adaptive Signal Proc.		ECE 659
EECS 662 Adv. Nonlinear Control		ECE 662
EECS 670 Current Topics in Computer Architecture	CSE 670	
EECS 692 Advanced Artificial Intelligence	CSE 692	
EECS 695 Neural Models and Psychological Processes	CSE 695	
EECS 698 Master's Thesis	CSE 698	
EECS 699 Research Work EECS	CSE 699	ECE 699
EECS 700 Special Topics in System Theory		ECE 700
EECS 720 Special Topics in SS Devices, Int. Circuits, Phys. Electr.		ECE 720
EECS 730 Special Topics in Electromagnetics		ECE 730
EECS 735 Special Topics in the Optical Sciences		ECE 735
EECS 750 Special Topics in Comm. and Inf. Theory		ECE 750
EECS 755 Special Topics in Signal Proc.		ECE 755
EECS 760 Special Topics in Control Theory		ECE 760
EECS 765 Special Topics in Stochastic Systems and Control		ECE 765
EECS 800 Sem Optical Sci&Engr		ECE 800
EECS 820 Seminar in S-S Electronics		ECE 820
EECS 990 Dissertation/Pre-Candidate	CSE 990	
EECS 995 Dissertation/Candidate	CSE 995	

COLLEGE OF ENGINEERING
COMPUTER SCIENCE & ENGINEERING
UNIVERSITY OF MICHIGAN

AMIR KAMIL

UNIVERSITY OF MICHIGAN
COLLEGE OF ENGINEERING
COMPUTER SCIENCE AND ENGINEERING

2260 HAYWARD STREET
ANN ARBOR, MI 48109-2121

February 9, 2023

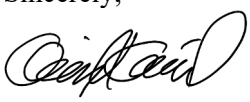
Dear College of Engineering Curriculum Committee:

The Electrical Engineering and Computer Science (EECS) department is planning to transition most 500-level and above courses to new CSE and ECE subject codes. The full details of which courses are changing designations are in the accompanying memo from the CSE and ECE Associate Chairs for Graduate Affairs and the attached spreadsheet. We are hoping to have the new course designations in place for Fall 2024.

The transition will require the submission of approximately 120 CARFs. In addition, we will need to work with other units to modify CARFs for cross-listed courses. Given the significant effort that will be required from the EECS course maintenance staff to generate these CARFs, we are requesting that the CoE Curriculum Committee approve the transition plan before we proceed to create the necessary CARFs. Once the CARFs are ready, we plan to submit them to the Curriculum Committee for final approval.

Thank you for considering this request. Please let me know if you have questions.

Sincerely,



Amir Kamil
Lecturer IV, Computer Science and Engineering
University of Michigan
akamil@umich.edu


MICHIGAN ENGINEERING
UNIVERSITY OF MICHIGAN

HLC Annual Audit Report and CoE Courses in Non-Compliance

February 8, 2023

Agenda

- Welcome & Introductions
- Project Details
  - Summary/Overview
  - Objective
  - Timeline
  - Deliverables
  - Roles & Responsibilities
  - Communication Plans
- Next Steps
- Questions

Project Overview

This request is for the team to review the annual HLC audit report and distill the existing URO report into a clear listing of non-compliant courses for each UG/Grad department chairs/units to review. They will direct/engage staff to modify courses that have easy fixes and create questions for the CCC to review for the harder to fix courses. The CCC will clarify contact hours/course categories so department chairs can resolve the harder to fix issues and will update their CoE Policy for the Assignment of Credit hours accordingly.

Project Objective

The report breakdown and suggested resolution frameworks will allow CoE to comply with the University and Provost's charge to resolve non-compliant courses as they pertain to each school/college Credit Hour Policy, to ensure continued Title IV student financial aid eligibility and that our programs are following applicable federal rules and guidelines.

Project Timeline

- Project Kickoff - 2/8/23
- Discovery Phase (WN 23)
- Planning (WN 23)
- Implementation (FA 23)
- Monitor (FA 23)
- Project ends 12/30/23
- Depends on level of engagement in groups.
- Ideally, this is resolved by end of WN 23 term (April), but this depends on the Working Group's progress with the URO's Annual Audit Report.

Risk Example

Risk Assessment What could happen that would likely have a negative impact on the project		
Risk Description	**Status**	**Potential Impact**
Instructors continue to implement course design that does not meet contact hour/credit hour policies	Ongoing	Existing courses continue to be structured with designs that do not meet contact hour/credit hour policies- continuing the list of unresolved courses flagged on the annual report (compounding work).
Courses are continued to be created or modified with ill-advised information (specific impact on asynchronous courses)	Ongoing	Delayed course creation for new courses; modification of existing courses is not being flagged for being out of compliance and therefore changes are happening to the course that perpetuate the non-compliance issue. Any exceptions would not resolve the underlying issue.
Quality of course design and/or emphasis placed on engagement of students with instructor	Area of concern	Continued Title IV student financial aid eligibility and complying with federal rules and guidelines.
Setting clear expectations and policies for faculty on course creation	Ongoing	A lack of common, agreed upon policies and procedures will likely create inconsistencies, administrative burden, and a high probability of recurring non-compliance.

Deliverables

1. Distilled report of the issues found in the URO report for review by department chairs.

2. A draft process framework is developed for CCC to review and implement for departments to resolve courses each semester

3. An clear, concise report (potentially developed within CoE) that can sustainably be maintained and run each semester

4. Updated CoE Credit Hour Policy based on decisions made by CCC to clearly outline what behaviors count as contact hours
   a. Coordinated with Mike Solomon, Vice Provost for Academic Affairs and Dean of Rackham
   b. Christine Gerdes, Special Counsel to the Provost

5. Benchmarking report of other schools and colleges with the University of Michigan.

Project Roles & Responsibilities

Role	Responsibility	Participant/s
PROJECT TEAM		
Project Sponsor	• Focus on business objective and delivering intended benefit • Ultimate decision-maker and tie-breaker • In kickoff and final report meeting as well as sponsor updates • Reviews approved final project plan and change requests	Kevin Pipe Vineet Kamat Rebecca Flintoft
Project Owner	• Planning and identifying a responsible party to maintain and upkeep artifacts from the project that need to stay updated. • In every meeting • Accountable for the success of the project • Manages project budget, resources, and management communication • Resolves high-level project issues • Acts as vocal project champion across the College	Xiaogan Liang Betsy Dodge April Hays
Project Manager	• Works with the project owner to develop the project management plan for the project. • Works with the project owner to set realistic and practical goals and the appropriate strategies for achieving them • Develops tools and techniques for distributing tasks, communicating with all levels of management, and ongoing project evaluation • Manages project scope changes, schedule updates, and risk mitigation • Runs project meetings and reports on project metrics	Sara O'Brien
Business Analyst	• Meet with groups to understand business strategy and needs • Perform a full analysis of what should be included in the project and make recommendations • Works closely with developers to be sure that goals are met • Assists with quality assurance	Atisha Vaughan-Shaw Yongqi Wu (student Intern)

Establishing the Working Group

Working Group Suggestions:

Faculty member and Curriculum Committee member needed

Stacie Benison and Chevette White will provide support for this group (eg. break down the HLC report by departments/units).

Role:

- Represents members from each unit in governance group (as needed)
- Attends regular team meetings
- Complete the work required to meet the project deliverables
- Provide input from their department/units to the project owners to aid in the completion of the project work
- The owners are part of these meetings
- Xiaogan to take the lead with the CCC work

Project Roles & Responsibilities

PROJECT GOVERNANCE		
Faculty Group	The CoE Curriculum Committee will review the questions submitted by the chairs and will coordinate with curriculum experts to determine/map what are allowable behaviors vs. what is not allowable and update the CoE Policy for the Assignment of Credit Hours.	CoE Curriculum Committee
Subject Matter Experts	Responsible for reviewing their own courses, fixing the easy ones and developing questions for the CoE Curriculum Committee to review and make a determination on.	The UG and Grad Chairs

Project Communications

Explain how communications will be handled.

- Online Tools
  - Email
  - Google Docs
- Meetings
  - Working Group
    - Weekly at first, may change as project goes along
  - Sponsor Updates
    - Milestones
    - Decisions/Changes

Next Steps

Where do we go from here?

- Create email groups (for each role)
- Present finalized project to CCC, Grad Chairs, UG Chairs have had this presentation
- Schedule working group meetings
  - Identify team members
  - Bring in subject matter experts
  - Timeline of work on report and sustainability of future reports prior to end of WN 23

Thank you!

1210 LSA Building
500 S. State Street
Ann Arbor, MI 48109-1382
Phone: 734.763.2113
Fax: 734.936.3148
ro.curriculum@umich.edu
ro.umich.edu

Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☐ New Course
- ☐ Modification of Existing Course
- ☑ Deletion of Existing Course

Date of Submission: 2023-02-10
Effective Term: Winter 2024

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 543	Dept (Home): Subject: Catalog:
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number
☐	Course Title (full title) Knowledge-Based Systems	Course Title (full title)
☐	Abbreviated Title (20 char) Knowledge-Based Sys	Abbreviated Title (20 char)
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Techniques and principles for developing application software based on explicit representation and manipulation of domain knowledge, as applied to areas such as pattern matching, problem-solving, automated planning, and natural-language processing. Discussion of major programming approaches used in the design and development of knowledge-based systems.	
☐	Full Term Credit Hours Undergraduate Min: 3 Graduate Min: 3 Undergraduate Max: 3 Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate Student, Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 543

☐

Grading Basis
- ☑ Graded (A – E)
- ☐ Credit/No Credit
- ☐ Satisfactory/Unsatisfactory
- ☐ Pass/Fail
- ☐ Business Administration

Grading
- ☐ Not for Credit
- ☐ Not for Degree Credit
- ☐ Degree Credit Only

Add Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

Drop Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

	CURRENT LISTING	**REQUESTED LISTING**
☐	Advisory Prerequisite (254 char) EECS 281 and grad standing or permission of instructor	Advisory Prerequisite (254 char)
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☐

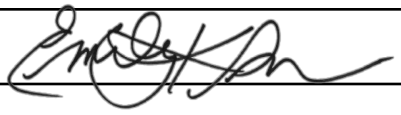
Course Components	Graded Component
☑ Lecture	☑
☐ Seminar	☐
☐ Recitation	☐
☐ Lab	☐
☐ Discussion	☐
☐ Independent Study	☐

Terms Typically Offered
- ☑ Fall
- ☐ Winter
- ☐ Spring
- ☐ Summer
- ☐ Spring/Summer

Cognizant Faculty Member Name: Emily Mower Povost Cognizant Faculty Member Title:

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Punam Vyas Email: vyas@umich.edu Phone: 647-1754

CoE Curriculum Committee Representative:		Print: Amir Kamil	Date: 2/10/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Emily Provost	Date: 2/10/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description Techniques and principles for developing application software based on explicit representation and manipulation of domain knowledge, as applied to areas such as pattern matching, problem-solving, automated planning, and natural-language processing. Discussion of major programming approaches used in the design and development of knowledge-based systems.	Course Description
Class Length Full term	Class Length
Contact hours (lecture): 3	Contact hours (lecture):
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
Tech Elective

Special resources of facilities required for this course:

Supporting statement:
The course was last taught in Fall 2014.

1210 LSA Building
500 S. State Street
Ann Arbor, MI 48109-1382
Phone: 734.763.2113
Fax: 734.936.3148
ro.curriculum@umich.edu
ro.umich.edu

Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☑ New Course
- ☐ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2023-02-02
Effective Term: Winter 2024

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Subject: Catalog:	Dept (Home): Nuclear Engin & Radiolog Sci Subject: NERS Catalog: 672
☑	☐ Course is Cross-Listed with Other Departments	☑ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
		CLaSP- SPACE- 545
☑	Course Title (full title)	Course Title (full title) High Energy Density Physics
☑	Abbreviated Title (20 char)	Abbreviated Title (20 char) High En Den Phys
☑	Course Description (Please limit to 50 words and attach separate sheet if necessary) Fundamental tools and discoveries of high-energy density physics, where pressures are above a million atmospheres. Fundamental physical models, equations of state, hydrodynamics including shocks and instabilities, radiation transport, radiation hydrodynamics, experimental technique, inertial fusion, experimental astrophysics and relativistic systems.	
☑	Full Term Credit Hours Undergraduate Min: 3 Graduate Min: 3 Undergraduate Max: 3 Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☑	Course Credit Type Undergraduate Student, Rackham Graduate Student, Non-Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Catalog:

☑

Grading Basis
- ☑ Graded (A – E)
- ☐ Credit/No Credit
- ☐ Satisfactory/Unsatisfactory
- ☐ Pass/Fail
- ☐ Business Administration

Grading
- ☐ Not for Credit
- ☐ Not for Degree Credit
- ☐ Degree Credit Only

Add Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

Drop Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

	CURRENT LISTING	REQUESTED LISTING
☑	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char) MATH 450, PHYSICS 405 & PHYSICS 406
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☑

Course Components
- ☑ Lecture
- ☐ Seminar
- ☐ Recitation
- ☐ Lab
- ☐ Discussion
- ☐ Independent Study

Graded Component
- ☑
- ☐
- ☐
- ☐
- ☐
- ☐

Terms Typically Offered
- ☐ Fall
- ☑ Winter
- ☐ Spring
- ☐ Summer
- ☐ Spring/Summer

Cognizant Faculty Member Name: Carolyn Kuranz

Cognizant Faculty Member Title: Associate Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Michelle Sonderman Email: mlwhit@umich.edu Phone: 734-936-3130

CoE Curriculum Committee Representative:	Won Sik Yang	Print: Won Sik Yang	Date: 2/2/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Todd Allen	Print: Todd R Allen	Date: 2 Feb 2023
Cross-Listed Department Chair:		Print: Aaron RIdley	Date: 2/2/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description	Course Description Fundamental tools and discoveries of high-energy density physics, where pressures are above a million atmospheres. Fundamental physical models, equations of state, hydrodynamics including shocks and instabilities, radiation transport, radiation hydrodynamics, experimental technique, inertial fusion, experimental astrophysics and relativistic systems.
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
N/A

Special resources of facilities required for this course:

Supporting statement:
The course (as NERS 590- Special Topics) was offered as a meet-together previously with CLaSP 545. The NERS and CLaSP departments are now requesting a permanent course listing.

Winter 2022

NERS 590 002 (SPACE 545) High Energy Density Physics

Instructor: Professor Kuranz (she/her)
Associate Professor of Nuclear Engineering and Radiological Sciences
2911 Cooley Building
ckuranz@umich.edu

Grader: Trevor Smith (he/him) smtrevor@umich.edu

Lectures: Mondays and Wednesdays 9:30 - 11:00 pm in 2918 Cooley. On occasion there will be classes scheduled on Fridays to make up for missed lectures due to travel. All lectures will be recorded.

Office Hours: Monday 10:30 - 11:00, Wednesday 10:30 - 11:30, Friday 3:30 - 4:30 You may always schedule an appointment by email.

Canvas Website: Canvas is an important tool for assignments, course announcements, and other class resources. Some assignments will need to be completed with Canvas. Please check the site regularly at canvas.umich.edu.

Grading: Homework 65% of grade, Project 35% of grade

Homework: There will be 10 homework sets consisting of 3 problems each where each problem is worth 10 points. Homework problems will taken from *High Energy Density Physics: Fundamentals, Inertial Fusion, and Experimental Astrophysics* 2nd edition unless otherwise noted. Homework problems may refer to material we have covered in class, material you are expected to cover on your own, or connect to material in a previous chapter. You are encouraged and will at times be required to use computational math tools (Python, Matlab). Late homework will be accepted. If you would like to redo homework for an improved grade you may do so. Email the corrected problems to *both* Trevor and Professor Kuranz. **All homework and revised problems must be turned in by April 19.**

Homework Honor Code Policy: You may discuss homework assignments with your fellow students, and complete the work with other students in the class, including working in a group around a common table and discussing problems as you work on them. You must submit individual work that is not a verbatim copy of any other student's work. Do not forget that even when you work in a group, you are individually responsible for the learning that should accompany homework completion.

Project: Each student will choose a paper and give a short (10 minute) presentation summarizing the research in the paper. The purpose of this project it to practice presenting scientific work and explore specific research in HEDP. The paper must be on an HEDP topic. The journal *High Energy Density Physics*, which is available from the University of

Michigan Library, is an excellent resource. You must submit your selected paper to Canvas by 2/7. Draft presentations will be given in small groups tentatively scheduled sometime between 3/18-3/27. You are required to submit written constructive comments for your peers. Final presentations are tentatively scheduled for 4/11 and 4/13. Project Grade Breakdown 70% for final presentations, 15% for draft presentation, and 10% for constructive comments on practice peer presentations, and 5% for submitting your paper topic.

COVID-19 Safety Policy: For the safety of all students, faculty, and staff on campus, it is important for each of us to be mindful of safety measures that have been put in place for our protection. By returning to campus, you have acknowledged your responsibility for protecting the collective health of our community. Your participation in this course is conditional upon your adherence to all safety measures mandated by the University, including properly wearing a face covering in the classroom. If you come to class without a mask one will be provided to you, if you are unwilling to wear it you will be asked to leave and if you are unwilling to leave class at that time, class will immediately end and the other students will be asked to leave for their safety and you will be reported to the Dean's office. If you are unable or unwilling to adhere to these safety measures while in a face-to-face class setting, you will be disenrolled from the class. For latest information on the University's COVID policy please visit campusblueprint.umich.edu

Please do not come to class if you are sick. Lectures will be recorded so that you view the lecture if you miss class.

Honor Code: The Honor Code will be strictly enforced in this course. Any suspected violations of the Honor Code will be promptly reported to the Honor Council. See above for specific Honor Code statement regarding homework for this class and see elc.engin.umich.edu/about/ for more information.

Students Requiring Accommodations: Students that have documented disabilities and require academic accommodations should make an appointment to discuss their needs with the course instructor. Students must contact the Services for Students with Disabilities, ssd.umich.edu to verify their eligibility for appropriate accommodations.

Inclusion Statement: It is my intention that students from all backgrounds and perspectives will be well served by this course, and that the diversity that students bring to this class will be viewed as an asset. I welcome individuals of all ages, backgrounds, beliefs, ethnicities, races, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, socioeconomic background, family education level, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. Your suggestions are encouraged and appreciated. If you have any questions or concerns regarding Diversity, Equity, and Inclusion you may contact the DEI leads in your home department www.engin.umich.edu/about/diversity/faculty/dei-department-leads/

In addition, I will gladly honor your request to address you by an alternate name or gender

pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records.

Student Resources: If you require additional resources please contact the CARE Center, care.engin.umich.edu or engin-support@umich.edu. In addition, If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. You can learn more about the broad range of confidential mental health services available on campus via caps.umich.edu/mitalk

Course Resources:

Required:

R Paul Drake *High Energy Density Physics: Fundamentals, Inertial Fusion, and Experimental Astrophysics* 2nd edition. This is available online through the University of Michigan library.

Additional Resources:

Ya. B. Zel'dovich, Yu. P. Raizer *Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena*

Jon Larsen *Foundations of High-Energy-Density Physics: Physical Processes of Matter at Extreme Conditions*

Jon Larsen and Jeff Colvin *Extreme Physics: Properties and Behavior of Matter at Extreme Conditions*

Amendments to Syllabus
Version 2 - Updated Student Resources Section, Updated Schedule, and Updated Course Resources
Version 3 - Office Hours added, Updated HW policy, Updated Lecture and Homework Schedule
Version 4 - Updated Lecture Schedule
Version 5 - Updated Lecture and Homework Schedule

Table 1: Tentative Schedule

Date	Lecture	Chapter	Sections	Homework Due
1-5	1	Ch 1	1.2, 1.3, 1.4	
1-10	No Class			
1-12	2	Ch 2	2.1, 2.3, 2.5	
1-17	MLK Day - No class			
1-19	3	Ch 3	3.1, 3.2, 3.3	HW1
1-24	4	Ch 3	3.5	
1-26	5	Ch 3 & Ch 4	3.9, 4.1	
1-31	6	Ch 4	4.1	
2-2	7	Ch 4	4.3, 4.4	HW2
2-7	8	Ch 4	4.5	Paper Topic Due
2-9	9	Ch 5	5.1, 5.2	
2-14	10	Ch 5	5.6, 5.7	
2-16	11	Ch 6	6.1, 6.3	HW 3
2-21	12	Ch 7	7.1	
2-23	13	Ch 7	7.3	HW4
2-28	Spring Break - No class			
3-2	Spring Break - No class			
3-7	14	Ch 8	8.1, 8.2	
3-9	15	Ch 10	2.2, 10.2	HW 5
3-14	16	Ch 10	10.5, 10.6	
3-16	17	Ch 9	9.1	HW6
3-21	18	Ch 9	9.2, 9.3	
3-23	19	Ch 11	11.5	HW7
3-28	20	Ch 11	11.3	
3-30	21	Ch 12	12.1	HW8
4-4	22	Ch 12	12.2	
4-6	23	Ch 13	13.1	HW9
4-11	24	Ch 13	13.4, 13.7	
4-13	Final Presentations			
4-18	Final Presentations			
4-19	All homework must be turned in			

University of Michigan
Winter 2022 Instructor Report With Comments
NERS 590 002 - SPACE 545 001
Carolyn Kuranz

10 out of 17 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
This course advanced my understanding of the subject matter. (Q1631)	9	1	0	0	0	0	4.9	4.6	4.7
My interest in the subject has increased because of this course. (Q1632)	8	2	0	0	0	0	4.9	4.2	4.6
I knew what was expected of me in this course.(Q1633)	8	2	0	0	0	0	4.9	4.6	4.5
I had a strong desire to take this course.(Q4)	6	3	0	0	0	0	4.8	4.1	4.6
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	0	1	9	0	0	0	3.1	3.0	2.9

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
Carolyn Kuranz seemed well prepared for class meetings.(Q230)	10	0	0	0	0	0	5.0	4.8	4.8
Carolyn Kuranz explained material clearly.(Q199)	10	0	0	0	0	0	5.0	4.7	4.7
Carolyn Kuranz treated students with respect.(Q217)	10	0	0	0	0	0	5.0	4.8	4.9

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	10	0	0	0	0	0	5.0

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Carolyn Kuranz was an excellent teacher. (Q2)	10	0	0	0	0	0	5.0

The medians are calculated from Winter 2022 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are graduate level with enrollment of 1 to 15 in College of Engineering.

University of Michigan
Winter 2020 Instructor Report With Comments
NERS 590-003: Special Topics II
Carolyn Kuranz

9 out of 18 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
This course advanced my understanding of the subject matter. (Q1631)	4	5	0	0	0	0	4.4	4.5	4.7
My interest in the subject has increased because of this course. (Q1632)	3	5	0	1	0	0	4.2	4.2	4.5
I knew what was expected of me in this course.(Q1633)	6	3	0	0	0	0	4.8	4.5	4.5
Overall, this was an excellent course.(Q1)	6	1	2	0	0	0	4.8	4.3	4.6
I had a strong desire to take this course.(Q4)	4	2	2	0	0	0	4.5	4.1	4.5
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	0	2	7	0	0	0	3.1	3.0	3.0
How did the unexpected change to remote course format affect your learning experience in this course this term? (SA=Very Positively Affected, A=Somewhat Positively Affected, N=No Effect, D=Somewhat Negatively Affected, SD=Very Negatively Affected) (Q1840)*	0	1	6	2	0	0	2.9	2.4	2.5

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
Overall, Carolyn Kuranz was an excellent teacher.(Q2)	7	1	1	0	0	0	4.9	4.6	4.7
Carolyn Kuranz seemed well prepared for class meetings.(Q230)	7	1	1	0	0	0	4.9	4.8	4.8
Carolyn Kuranz explained material clearly.(Q199)	6	2	1	0	0	0	4.8	4.7	4.7
Carolyn Kuranz treated students with respect.(Q217)	8	0	0	0	0	0	5.0	4.8	4.9

The medians are calculated from Winter 2020 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are graduate level with enrollment of 16 to 74 in College of Engineering.

Written Comments

This course advanced my understanding of the subject matter.(Q1631) (Comments)

Comment
- I learned a lot, but at the same time we covered a lot over a long time. But I think as a survey of a field it was pretty good