The University Senate of Michigan Technological University

Proposal 11-17

(Voting Units: Academic)

"Proposal for a Minor in Naval Systems Engineering"

(Department of Mechanical Engineering – Engineering Mechanics)

1. Date February 16, 2017

2. **Department Proposer** Andrew Barnard, Department of Mechanical Engineering

3. Introduction

The Department of Mechanical Engineering – Engineering Mechanics proposes to offer a minor program in Naval Systems Engineering. The goal of this proposal is to create an undergraduate science and engineering program at Michigan Tech that focuses students in STEM topics of Navy interest, provides real-world problem-solving based learning, and compels students to seek employment within industries that support Navy missions or within the Navy (including Navy laboratories) upon graduation or pursue graduate research in Navy related STEM fields.

4. Rationale

Across the nation, there are approximately 19 accredited university programs in Naval Architecture and Marine Engineering, which concentrate primarily on ship and floating platform design. The modern Navy's interests, span engineering disciplines ranging from space systems to advanced physics. There is no need to replicate existing university programs or to add to existing capabilities. We propose a minor degree program to empower additional Navy STEM students and provide them with needed experiences inside- and outside-of-the-classroom, to familiarize them with the specific global technical challenges faced by today's Navy.

All students electing for this minor will be required to take an introductory course in Naval Systems and Platforms to gain an introductory understanding of design challenges in Naval Systems. The credits earned through the complementary SENSE (Strategic Education through Naval Systems Experiences) Enterprise program combined with existing and new course offerings will qualify students for a Naval Systems Engineering Minor. SENSE Enterprise credits accepted for the minor will be the senior-design-equivalent courses of ENT4950, ENT4960, and ENT4961 and the student's project must be an approved project in the field of Naval Systems. This will help them to gain employment in Navy related STEM careers and be ready for on-the-job success from day-one. We envision the minor to encompass Mechanical Engineering core courses and senior level electives both within Mechanical Engineering and other engineering fields. Ocean engineering, materials science, and other courses are part of the minor program to contribute well-rounded naval engineers and scientists to the workforce. In addition, this will provide a training ground for exceptional students to gain skills for graduate work in Navy STEM fields.

The proposed minor program will concentrate efforts in four core areas of Navy interest: shock and vibration; autonomous vehicles; hydrodynamic modeling, and ocean sensors and sensing platforms. This will be accomplished with the generation of three core courses and the incorporation of an existing hydrodynamic modeling course, that

will form the basis of the minor. These core courses will be heavily supplemented with real, "at sea" and in-lab experience utilizing the GLRC research and survey vessels, our sub-surface fleet of autonomous and remotely operated vehicles and our array of advanced acoustic and vibration sensors (active and passive).

5. Details

I. **Title of Minor**: Naval Systems Engineering

II. **Description**: This ME-EM Minor focuses on providing students a background for careers in naval systems engineering. The coursework includes topics related to Naval Systems, structures, sensing platforms, hydrodynamic modeling, acoustics and vibrations, and design and control of autonomous vehicles. This minor is most suitable for undergraduate mechanical engineering majors. But this minor has been designed to accommodate other engineering majors, as well as students involved in the SENSE (Strategic Education through Naval Systems Experiences) Enterprise.

III. **List of Courses**: Students will be required to complete at least 19 credit hours, with a minimum of 9 credit hours at the 3000-level or higher. These courses are highlighted in the tables below. Courses are planned to be offered in the semesters noted. Spring (odd AY) indicates courses taught in alternate years beginning with the 2017-2018 academic year, Spring (even AY) indicates courses taught in alternate years beginning with the 2016-2017 academic year. The listed prerequisites are those not listed for the minor.

Required Courses (Minimum 13 credits)

Course	Credits	Title	Term	Prerequisites
MEEM 2150	3	Mechanics of Materials	Fall, spring, summer	MEEM 2110
		Or		
ENG 2120	4	Statics-Strength of Materials*	Spring	MA 2160, PH 2100, ENG 1102
MEEM 3210	3	Fluid Mechanics	Fall, spring, summer	MEEM 2200, MEEM 2700 (C), and (MA 3520 or MA 3521 or MA 3530 or MA 3560)
		Or		
MEEM 3201	4	Introductory Fluid Mechanics & Heat Transfer	Fall, spring, summer	MEEM 2201 and MEEM 2911 and (MA 3520 or MA3521 or MA 3530 or MA 3560)
		Or		
ENG 3200	4	Thermodynamics/Fluid Mechanics*	Fall, spring	MA 2160 and CH 1112 or (CH 1150 and CH 1151) and PH 2100 and ENG 1102
MEEM 4850 **	3	Naval Systems and Platforms	Fall	MEEM 3201 or ENG 3200 or MEEM 3210
ENT 4950	2	Enterprise Project Work V***	Fall, spring, summer	Senior Design Ready in Major
ENT 4960	2	Enterprise Project Work VI***	Fall, spring, summer	ENT 4950

**Minor credit cannot be granted for ME majors for these two courses*

***New Course*

**** Requires naval systems project approved by minor advisor*

Core Elective Courses (at least 3 credits)

Course	Credits	Title	Term	Prerequisites
ENT 4961	1	Enterprise Project Work VII***	Fall, spring, summer	ENT 4960
MEEM 4702	3	Shock and Vibration	Spring	(MEEM 3911 and MEEM 3750) or (MEEM 4700 or MEEM 4775)
MEEM 4707	3	Autonomous Systems	Spring	MEEM 3750 or MEEM 4700
ENVE 4930 ****	3	Introduction to Hydrodynamic Modeling	Spring	None

5000-level substitutes for core elective courses

Course	Credits	Title	Term	Prerequisites
ENVE 5590 ****	3	Introduction to Hydrodynamic Modeling	Spring	Graduate Level Restriction or instructor approval

****ENVE 5590 special topics class in hydrodynamic modeling is an existing course and will be given a regular course number and be co-listed as a 4000/5000 level course in the binder process in fall 2017 for subsequent years. For Fa17, the 4000 level version of this course will be an independent study course, ENVE 4930. Students can take the 4000 or 5000 level course, but not both for minor credit.*

Related Elective Courses (remaining credits)

Course	Credits	Title	Term	Prerequisites
MY 4155	3	Composite Materials	Spring	MY 2100
MY 4164	1	Fundamentals of Corrosion	Fall	CH 1150 and CH 1151
MY 4165	3	Corrosion and Environmental Effects	Fall	MY 2100
MY 4800	3	Material and Process Selection in Design	Spring	MY 2100
EE 3173	4	Hardware/Software System Integration	Fall, Spring	(EE 2304 or EE 2174) and (EE 3130 or EE 3131) and (CS 1141 or CS 2141) and CS 3421 and (MA 3710 or EE 3180)
EE 4227	3	Power Electronics	Fall, Summer	EE 3120 and (EE 3130 (C) or EE 3131)
EE 4228	1	Power Electronics Lab	Fall	EE 4227(C)
EE 4252	4	Digital Signal Processing and its Applications	Fall	EE 3160
EE 4490	4	Laser Systems and Applications	Spring	EE 3140
MEEM 4150	3	Intermediate Mechanics of Materials	Fall	MEEM 2150
MEEM 4210	3	Computational Fluids Engineering	Fall	MEEM 3230 (C)
MEEM 4170	3	Failure of Materials in Mechanics	Spring	MEEM 3501
MEEM 4180	3	Engineering Biomechanics	Fall	MEEM 2700 and MEEM 2150

MEEM 4630	3	Human Factors	Fall	Senior standing
MEEM 4650	3	Quality Engineering	Fall	MA 3710 or MA 3720
MEEM 4701	4	Analytical and Experimental Model Analysis	Fall	MEEM 3000 and MEEM 3700
MEEM 4704	3	Acoustics and Noise Control	Spring	MA 3160 and MEEM 2700
MEEM 4705	3	Introduction to Robotics and Mechatronics	Fall	MEEM 4700(C)
MEEM 4295 / EE 4295	3	Introduction to Propulsion Systems for Hybrid Electric Vehicles	Fall, Summer	MEEM 2200 or ENG 3200
CS 4471	3	Computer Security	Fall	CS 3411 or CS 4411
CS 4496	3	GPU and Multicore Programming	Fall	CS 3411 and CS 3421
CS 4821	3	Data Mining	Spring	(CS 3425 or MIS 3100) and (MA 2330 or MA 2320 or MA 2321) and (MA 2710 or MA 2720 or MA 3710)
EC 4050	3	Game Theory/Strategic Behavior	Fall, Summer	UN 1015 and (UN 1025 or Modern Language – 3000 level or higher)

4. New Course Descriptions:

MEEM 4850 Naval Systems and Platforms Concepts of semi- and fully-autonomous naval and marine sensors and sensing platforms demonstrated through classroom learning and hands-on experiences. Laboratories will focus on operating sensors and sensor packages, in oceanographic and other applications.
Credits: 3.0
Semesters Offered: Fall, spring, on demand
Pre-Requisites: None

This course will be an expansion of the current ENT 3987 two credit course in Naval Systems and Platforms that was developed through the current ONR grant. The current course has 1 credit of recitation and 1 credit of laboratory. An additional recitation credit will be added to increase the technical content of the course. By co-listing the class as a 4000 level course in MEEM and GE, students from both departments will be able to use the course as a technical elective as well. Until the new course has undergone the binder process, it can be taught as a 4990 special topics course in MEEM.

The purpose of Naval Systems and Platforms (Fall 2016), is to provide a brief but comprehensive introduction to the environment within, upon and over, which Naval Systems are expected to operate. The course provides topics of applied ocean physics, taught at the intermediate calculus level. In addition, the laboratory portion of the course provides both theatrical as well as hand-on, experiential learning. Laboratories involve "at sea," research vessel experience in operating sensors and sensor packages, to achieve goals of interest in coastal oceanographic applications. These include operation of; an autonomous underwater vehicle, remotely operated underwater vehicles, acoustic sensing and directional finding instrumentation and environmental sensing platforms. The ultimate goal of the course is to expose the interested Naval Engineering student to the complexities of the nearshore ocean environment and to the theoretical foundation upon which our current physical understanding is based.

ENVE 4930/5590 Introduction to Hydrodynamic Modeling This is an introductory course of numerical methods used in oceanography and Limnology. Topics include numerical model formulation, model simulation, data analysis, and parameter estimation. It provides fundamental concepts and various numerical methods used in ocean and lake modeling. An introduction to the basic physical processes in the oceans and large lakes and their numerical representation using governing equations will also be presented. Students will also have a chance to construct and use their own simplified numerical models to solve basic hydrodynamic questions in class projects. This class is aimed for helping student understand fundamental concepts of numerical modeling with its strengths and limitations and its application to the problems of coastal oceans and large lakes.
Credits: 3.0
Semesters Offered: Spring, on demand
Pre-Requisites: None

This is a current graduate level special topics course in ENVE taught by Dr. Pengfei Xue. The course will be given a regular course number and co-listed as a 4000 level course in ENVE during the binder process in 2017.

5. Estimated Costs: Costs for developing new courses and implementing are covered through the awarded ONR STEM education grant, discussed above. No additional direct costs are incurred specifically for this minor.

6. Library Resources: No additional library resources are requested to support this minor.

7. Planned Implementation date: Fall 2017