TO: The Engineering Faculty

FROM: The Faculty of the Department of Agricultural and Biological Engineering

RE: New Course – ABE 44400, Design and Advanced Manufacturing Processes for Internal Combustion Engines

The Faculty of the Department of Agricultural and Biological Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ABE 44400 Particle, Design and Advanced Manufacturing Processes for Internal Combustion Engines Sem 1 and 2, Cr 3
Pre/Co-Requisites: ABE 32000 & ABE 33000 or Instructor's Permission
Restrictions: None

Course Description: This course introduces the manufacture and assembly of machined piece parts into a functional assembly. The creation of a prototype internal combustion engine will be utilized as the base project for the course, and students will design and create the parts and final assemblies. Students will be given a background on the process flow of modern manufacturing by general metal machining processes, manual machine tool operation, digital machine tool programming, numerical machine tool operation, the measurement of critical machining output variables, and the assembly of piece parts into subassemblies and final products. Course participants will work as a team to develop their production parts, final presentation, and final report.

Reason: This class will enhance the capabilities of our graduates to participate in modern manufacturing enterprises at the entry level by providing hands-on experience in the conversion of CAD drawings into physical parts using the common methodologies of industry. ABE is uniquely positioned to offer this instruction as off-road power units are an essential feature of the equipment used in our industry, and the newly updated ABE shop contains a full collection of traditional manual machine tools and a new CNC lathe, and a new CNC 5-axis mill. ABE students will gain experience designing individual parts, reviewing and revising those designs, and then machining those individual pieces. This course will prepare students for a variety of positions in manufacturing and manufacturing support.

Details of this course are outlined in the appended material below.

Nathan S. Mosier, Head
Department of Agricultural and Biological Engineering

Agricultural & Biological Engineering 44400
Design and Advanced Manufacturing Processes for Internal Combustion Engines
Fall 2022

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Instructor:	Dr. Bob Stwalley ABE 2014 Student Help / Office Phone-in Hours:	rms3@purdue.edu MW 11:30-13:20 or By Appointment @ 765-494-1791
Teaching Assistants:	Mr. Tyler Field ABE 3098	tfield@purdue.edu By Appointment

Texts:

Off-Road Vehicle Engineering Principles.
Goering, Stone, Smith, & Turnquist

Kinematics and Dynamics of Machines 2nd
Martin

Mechanics & Thermodynamics of Propulsion 2nd
Hill & Peterson

Engine & Tractor Power
Goering & Hansen

Mechanical Metallurgy 3rd
Dieter

Meeting Times: Lecture - 50 minutes per week for 16 weeks and Lab - 300 minutes per week for 16 weeks

Global Learning Outcomes: Upon the completion of the course, students shall be able to:

- Identify and understand the forces present on various components of internal combustion engines (ABET 1);
- Be able to design specific components for internal combustion engines and plan for their manufacture (ABET 1);
- Identify the sequence of machining operations for the construction of engine components (ABET 1);
- Be able to download specific instructions to numerically controlled machines to execute manufacturing instructions for specific parts (ABET 1);
- Be able to perform specific operations on traditional machine tools to create specific engine parts (ABET 1);
- Understand how to measure critical dimensions in manufactured parts (ABET 1);
- Understand the concepts of component assembly to create a functional device (ABET 2);
- Be able to understand the safety concerns of machine shops and how to mitigate danger to personnel and equipment (ABET 4);
- Be able to spread workloads between colleagues, assist one another in self-learning, and collaborate to meet collective course objectives (ABET 5);
- Understand the concepts of professionalism, ethical responsibility, and integrity when applied to technical projects (ABET 4); and
- Enhance written and oral communication skills through the production of a comprehensive final report and summary technical presentation (ABET 3).

Specific Classroom Policies: The instructor's rules and expectations are:

1) Students should attend instruction periods as 'active learners' and be considerate of others in the formal class periods.
2) No Phones on during class. **No computers on,** unless asked to use them. You will be asked to leave for the period, if you are a distraction to the instructor or other students. A second violation will incur a harsher penalty.
3) This is a 'flipped' class. It is your responsibility to cover all material on your own. All learning material is available in BrightSpace. I will assist with confusing or difficult concepts in class, but please don't ask the instructor for a separate lecture or how to catch-up from what you haven't done. That does not mean that I won't help you. I am here to assist you, but you must try to learn the material first, on your own and with your learning team. Once you have done that, I will take all the time we need to get you or your team through the tough spots.
4) If you have a legitimate reason for which you must miss class, you must notify the instructor ahead of time and make alternative arrangements!
5) You must bring your all of your materials to classes and labs.
6) You will work on a learning team. This is an important resource for you, and it will be a problem for the team and a major loss for you, if you do not participate.
7) All written assignments are to be typed 12pt Times New Roman font, 1.15 spacing, in complete English sentences, with no electro-Twitter speak or misspellings.

8) All labs will involve shop work. There will be **NO** horseplay during Labs! You must dress safely and appropriately for the lab site.
9) This course is extremely time intensive! You are expected to devote at least 10 hours per week to this class. It may take more to do a good job grade.
10) This class uses BrightSpace as its course management software. There are classroom materials in common for the whole class posted there.
11) Email is the official form of communication for this course. If the instructor has a critical piece of information for the class, he will post it via email. You are responsible for watching your university email address, as official communication will be done through BrightSpace and your university account. If the material is posted to email, it will be considered that you received the information.
12) It is your responsibility to complete your individual work and team projects. Don't ask the instructor how much time per week you should put into your work. Your overall objectives should be clear. Complete your work to achieve the learning outcomes! It will take whatever it takes.
13) You **MUST** complete the term paper and presentation to pass the course. Everyone on the team will fail the course, if the report and presentation are not completed satisfactorily in a timely fashion. There is no leeway on formal report submission deadline. Your team must prepare a final project presentation for the instructor and class! You must attend the Presentation Session at the end of the term and submit a final report to pass the course. You must turn-in your formal report by the published deadline to pass the course and receive a passing grade.
14) Enjoy yourself; this class and the overall experience should be fun and satisfying for everyone.

Grading: If you do the work, I promise you will have the chance to get a good grade. The total possible base score for the class is 1250 points, broken-down as follows:

Attendance	50	
Homework	50	(HW #0 – 4: 10 points each)
Lab Qualifiers	100	(Lab #1 – 5: 20 points each)
Training Project	100	
Review Quiz 1	50	
Midterm Exam	100	
Team Project	150	(Specific work for current long-term project assigned for completion during the semester in Lab #6 – 13)
Team Term Presentation	100	
Team Term Paper	150	
Participation/Work Effort	150	Instructor's Discretion
Review Quiz II	50	
Final Exam	200	
TOTAL POINTS	1250	Nominal Score – Extra Credit Available

There may be more points added as the course progresses. **The basic course scoring will be on a 90/80/70/60 scale.** However, this will be based upon the top score in the class, and you will have multiple

extra credit opportunities of various kinds (1-10 pts ea.) throughout the term. Use them wisely. A grade, like your ultimate success in life, is both a reflection of how well you learned the material and how well you took advantage of the additional opportunities given to you.

Data about student performance in this course is collected and kept for research, evaluation, and accreditation purposes. This data may be used in a variety of ways, but no readily identifiable personal information will ever be released without prior permission. Please see the instructor, if you have any concerns in this area.

In this course, the examinations and term paper deadlines are NON-FLEXIBLE. You have flexibility to do your work in the shop. Use it wisely! Don't wait until the last minute to do your work. You'll never make it!

Course Content:

Date	Module	Topic	Text Assignment	Submissions
Week #1				
xx Jan	LM #0	Lec #1: Introduction / Perspective		
xx Jan	LM #1	Lab #1: Safety Review / CAD Fundamentals		
Week #2				
xx Jan	LM #2	Lec #2: Machine Shop Basics		
xx Jan		Lab #2: Traditional Shop Overview		
Week #3				
xx Jan	LM #3	Lec #3: Computer Aided Manufacturing Fundamentals		
xx Jan		Lab #3: Measurement, Tolerances, & Materials		
Week #4				
xx Feb	LM #4	Lec #4: CNC Basics I		
xx Feb		Lab #4: CNC Mill		
Week #5				
xx Feb		Lec #5: CNC Basics II		
xx Feb		Lab #5: CNC Turning		
Week #6				
xx Feb	LM #5	Lec #6: Reciprocating Engine Fundamentals I	ORVEP 4	
xx Feb	TERM PROJECT	Lab #6: Engine Parts Manufacturing I		
Week #7				
xx Feb	REVIEW I	Video: Prep for Exam I: LM #0 – LM #4		
xx Feb	EXAM I	Night Exam: Machining Test		
Week #8				
xx Mar		Lec #7: Reciprocating Engine Fundamentals II	ORVEP 12	
xx Mar		Lab #7: Engine Parts Manufacturing II		
Week #9				
xx Mar	LM #6	Lec #8: Gear Manufacturing	KDM 12 & ETP 4	
xx Mar		Lab #8: Engine Parts Manufacturing III		

Week #10				
xx Mar	LM #7	Lec #9: Cam Manufacturing	KDM 10	
xx Mar		Lab #9: Engine Parts Manufacturing IV		
Week #11				
xx Mar	LM #8	Lec #10: Turbomachinery I	ORVEP 8	
xx Mar		Lab #10: Engine Parts Manufacturing V		
Week #12				
xx Mar		Lec #11: Turbomachinery II	MTP 8 & 9	
xx Mar		Lab #11: Engine Parts Manufacturing VI		
Week #13				
xx Apr	LM #9	Lec #12: Lubrication & Wear	ORVEP 5	
xx Apr		Lab #12: Engine Parts Manufacturing VII		
Week #14				
xx Apr	LM #10	Lec #13: Engine Cooling	ORVEP 9	
xx Apr		Lab #13: Engine Parts Manufacturing VIII		
Week #15				
xx Apr	REVIEW II	Prep for Exam II: LM #0 – LM #10		
xx Apr	PAPERS			Term Papers Due Wednesday
xx Apr	PAPERS	Paper Session		Term Project Presentation
Week #16				
xx Apr	EXAM II	Final Exam: Cumulative Course Test: LM0 – LM10		

Miscellaneous Mandated Material from Mitch: The schedule is subject to change due to weather emergencies or other circumstances beyond the control of the instructor. We will figure out how to fix things, if it becomes necessary to do so. Everything that can be done to make this a safe and productive learning environment has been done (consider how COVID went!). If there is a problem, everyone will cooperate and follow the instructor's instructions regarding shelter, evacuation, or any other procedure necessary.

Students with disabilities must be registered with Disability Resource Center (DRC) in the Office of the Dean of Students before classroom accommodations can be provided. Please contact the DRC to discuss your personal needs here: https://www.purdue.edu/studentsuccess/specialized/drc/index.html.

Any student facing food or housing insecurity should contact the Dean of Students or this course's instructor, if you are uncomfortable going to the Dean of Students. ABE is here to help you.

Academic dishonesty is **NOT** tolerated at Purdue University. Penalties can include up through dismissal from the institution. It's not worth it. Do your own work! You can work with a study group to confirm you concepts and solutions, but in the end, you must submit your own work on each problem.

"As a Boilermaker pursing academic excellence, I pledge to be honest and true in all that I do. Accountable together, we are Purdue."

Justification for and Differences between Advanced Manufacturing Processes and Testing for Internal Combustion Engines & Design and Advanced Manufacturing Processes for Internal Combustion Engines

ABE proposes to add two new cross-linked courses ABE 44400 and ASM 44400, based upon the manufacture of prototype, experimental internal combustion engines. ABE has been running this course as a special projects class for three years and has attracted both engineering-based (19) and technology-based (8) students, and our intention is to retain that general accessibility for STEM-based students. Maximum enrollment thus far had been 9. This class provides student with a hands-on experience using the typical subtractive manufacturing processes used in industry today for the manufacture of both commercial and consumer products. Although all students received instruction on machine tools and were provided with operational time using the shop equipment, it is fair to say that specific tasks were delegated according to student skills capability. Engineering students concentrated upon designing parts and modifying designs and numerical machining instructions to produce the correct parts. Technology students concentrated on the production of parts that fit together in an assembly and the testing of those parts and assemblies. It would be the intention of the course instructor to continue this division of labor within the courses, focusing the students on areas within manufacturing where their skills will be utilized in industry. While the accommodation of a variety of pre-existing skill levels will make the class somewhat multi-level for its student clientele, the focus will definitely be on an academic examination of machining processes, not engine reseach. During the first two offerings, it is our intention to limit class size to 12 students each, growing to 20 each once some initial experience teaching the course has been created. Lectures are planned to occur simultaneously, since they will pertain to the instruction regarding the operation of the machine tools. All students will be required to pass the same shop safety and machining training before being allowed to use either the manual or numeric machine tools. Scheduled labs will be run separately for technology and engineering students, so that specialized, discipline appropriate instruction can take place. Shop facilities in the new ABE building will be utilized for the class, primarily 1140 (engine's lab), 1126 (traditional machine shop), and 1120 (numerically controlled machine shop). Individual or open lab time will occur on the student's individual schedule to maximize flexibility. ABE 44400 will introduce manufacturing processes and technologies in a course that will be appropriate for anyone enrolled within the College of Engineering. ASM 44400 will introduce manufacturing processes and technologies in a course that will be appropriate for anyone enrolled within the College of Agriculture or the Polytechnic.