ACADEMIC PORTFOLIO

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OVERVIEW

The purpose of this academic portfolio is three-fold:

- First and foremost it documents—*in an empirical, evidence-based fashion*—my activities and accomplishments in research, teaching, and service and provides some context for those activities and their significance in nuclear science and technology and in a global sense.

- Second it is a vehicle for organizing my research, teaching, and service priorities, and for developing and refining my short- and long-term career goals. As such it provides a method for me to evaluate my own strengths and weaknesses and target my professional activities to take advantage of those strengths and address weaknesses.

- Finally it is a way to describe my key activities to professionals in other fields in a clear, concise fashion for grant applications, proposed collaborations, dissemination of research results, and promotion of the Nuclear Engineering Program, Department of Mining and Nuclear Engineering, and Missouri University of Science and Technology.

A graduate of Purdue University, I received my PhD in Nuclear Engineering in 2012. My advisor was Distinguished Professor Mamoru Ishii, a world-renowned expert in nuclear reactor thermal hydraulics and multiphase flows. On receiving my doctorate I was hired by Professor Ishii as a postdoctoral researcher. My work there included managing all aspects of the laboratory, mentoring graduate students, and key research in multiphase flow. That research included the development of a new type of electrical conductivity probe, various experimental measurements of interfacial area transport phenomena, and the development of a computer code using the one-dimensional two-fluid model to predict multiphase flow development. In 2014 I joined the faculty of Mining and Nuclear Engineering at Missouri S&T as a member of the Nuclear Engineering Program as an Assistant Professor. I very quickly developed a long-term plan for teaching, set key goals for my research program, and involved myself in forward-looking service activities.

The details of those activities will be discussed throughout the rest of this portfolio, along with descriptions of the rationale and significance of those activities. The portfolio will begin with a description of my research program, which has resulted in $563,833 in grants, 32 peer-reviewed journal publications and 467 citations for an h-index of 12 and an i10 index of 15. In addition 8 more publications are under review. This will be followed by a description of my teaching philosophy, which focuses on team-based, problem-based learning. It will also include a description of my continuing professional development activities and how those activities have shaped my teaching philosophy. Finally I will discuss my service activities, which have been focused on influencing the future development of the Nuclear Engineering Program and Department of Mining and Nuclear Engineering, as well as expanding the visibility of my research program and related activities.
PERSONAL STATEMENT

I was a junior in Nuclear Engineering at Purdue University, and was struggling during the Fall semester of that year. I was working two jobs to pay tuition and taking a full time course load. Staying up until 2 a.m. working meant that I was missing some class time, particularly in the course “Fundamentals of Nuclear Engineering”. My partner in the course dropped out of sight after the first exam, so I was finishing group homework on my own each week. I was still making an A in the course, but it would be generous to call it a challenge. The professor teaching the course took notice, and took me aside after class one day to ask me what was going on. I explained about working and my partner not being around and promised her that I would ask for help if I needed any, then went on my way. I really didn’t think anything of it. A few days later she took me aside again and said “I think you need to be involved in research. Pick any professor in the department that you would like to work with and I will talk to them to recommend you.” I spent a few days looking through the research each faculty was involved in and what courses they were teaching. In the end I asked for a recommendation to Distinguished Professor Mamoru Ishii, a world-renowned expert in nuclear reactor safety. The next day she told me I should show up at his office at 9:00 on Thursday morning.

I will admit to being just short of terrified about meeting him. I hadn’t had any courses with him, and I had heard from some of the graduate students that – let’s just say he had very high standards, and not all of the students met those standards. However the angst was really unnecessary. We spoke briefly about some of the research he was doing, he had a few questions about my transcript and work background, and we discussed my research and career interests. After about half an hour he agreed to hire me as an undergraduate laboratory assistant to work on a new project. I found out later that I am the only undergraduate student he ever hired. This really turned my year around. I still had to work two jobs, but now one of them was interesting and directly related to my chosen field. I had additional academic support, both because I was spending more time with faculty and because I had the chance to work with graduate students in the field. As a faculty member myself, I hope that I can have that kind of impact on the students I work with every day.

So I decided that I wanted to follow in their footsteps. I continued on to graduate school with Prof. Ishii as my advisor. In addition to research I was active in service and sought out chances to teach. I was one of the founding members of the Nuclear Engineering Ambassadors at Purdue University, a group of top students given responsibility for assisting in recruitment and fundraising events. I was the graduate student representative for our local chapter of ANS. I travelled to local high schools to give presentations. When faculty were traveling to conferences, I asked if I could teach their class while they were gone. This was – and still is – sometimes difficult for me because I am not naturally outgoing and talkative. But it was important to me, and well worth the effort. In research, I asked to help write proposals and be given more responsibility. After watching me talking with prospective freshmen one morning, the student services assistant
responsible for advising all the students in the department told me “If you don’t become a professor and teach, you will be wasting your talent.”

My advisor appreciated the fact that if he asked me to do something, he knew that if he left me alone it would get done on time without the need for close supervision or micromanaging. After I earned my doctorate he hired me as a postdoc. In that position I was responsible for managing all of the active research projects and acting as an interface between my advisor and the graduate students working in his laboratory. This was my first exposure to the administrative side of academic research, and I learned a lot in the first few months. After about a year and a half we met to discuss my future plans. He said that “I think you have learned everything you can from working here, you are ready to move on”. A few months after that, I was hired at Missouri S&T.

I have had to overcome challenges while here as well. Due to renovations and construction, my laboratory was not complete until three years after my arrival. I have been moderately successful in obtaining grants for computational and analytical research, but experimental research is my true passion and I am now beginning to submit grant proposals for experimental research and develop experimental capabilities in earnest. I have also been trying to balance research efforts with higher-than-usual teaching loads for an early-career faculty member. I have often taught two or three courses each semester, and had to prepare seven different courses (eight different course numbers) during my first seven semesters as a professor. However constructive criticisms from the students have been very helpful in adjusting my teaching methods to the needs of the learners.

On a personal note the birth of my two sons – Ethan just before I arrived at Missouri S&T and Larkin two years later – has been both a blessing and an adventure for my wife Amanda and I. Ethan spent two months in the hospital before he was able to come home – two weeks of that attached to a heart-lung machine that breathed and pumped his blood for him – due to a serious case of pneumonia. But he fought very hard to heal and he has grown into a precocious and energetic five-year-old. Larkin loves to talk about everything he sees, make up songs about his everyday life, and push any and every boundary in his life. It is a joy to arrive home at the end of each work day to spend the evening playing with cardboard boxes, blocks, Legos, cars, and whatever else seems interesting to them that day.

Overall I believe that I have been quite successful. The remainder of this document will cover, in detail, the numbers proving that case: research dollars, CET scores, and everything else. But more important to me are the students who have told me “I am lucky that you were my advisor,” “You are going to be a great teacher,” or “I learned so much from that class, it has really helped in my other classes.” I have already begun to have an impact on the students I interact with every day, as the professor in that Fundamentals of Nuclear Engineering course had on me.
RESEARCH AND SCHOLARSHIP

INTRODUCTION
All university-level research programs have certain common goals:

- **Discovering** new knowledge,
- **Integrating** that knowledge with what we already know to achieve a deeper understanding of the world around us,
- **Applying** knowledge to make the world a better place, and
- **Teaching** that knowledge to others so that they can continue the process.

Within that framework each individual faculty member has specific long- and short-term goals related to the development of their field. My research has been focused on the application of the principles of heat, mass, and momentum transfer to nuclear reactor systems.

In the long-term, my goal is to **become a nationally and internationally recognized expert** in multiphase flow processes, specifically in the improvement of nuclear reactor performance and safety and energy efficiency. I plan to accomplish this goal by:

- Improving our scientific understanding of key phenomena important to industrial applications such as turbulence, interfacial behavior, and so on.
- Applying fundamental principles of physics to develop, evaluate, and refine models for multiphase flow systems
- Validating those models using high-quality experimental measurements and innovative measurement techniques
- Mentoring PhD candidates to produce qualified, creative faculty to continue developing the field.

My general research interests have been focused in a few key areas. One has been **creating new methods for evaluating and optimizing multiphase flow models**. From this area has grown an interest in the development of new instrumentation and the continuing improvement of existing types of instrumentation for measuring important parameters in two-phase flows. Finally, I have also been involved in applied research, solving key problems related to industrial applications of multiphase flows. These areas are detailed below.

Throughout this process, my efforts have led to numerous publications and citations and significant research funding. Figure 1 shows the number of peer-reviewed journal publications that have been produced each year. This number does not include a book chapter on two-phase flow in large diameter pipes, nor does it include peer-reviewed conference proceedings. The figure shows an average of more than **4 publications per year** over the last five years, however it also shows that I have 8 publications under review. Perhaps more important than publishing is making sure that people are reading and using the work. Figure 1 also shows the rate of citations since 2009. As the figure shows, the number of citations has been steadily increasing each year. Based on data obtained from my Google Scholar profile, I have a total of 476 citations, an **h-index of 12**, ...
and an i10-index of 15. Funded research grants are listed in Table 1. As the table indicates, I have obtained $563,833 in finding while at Missouri S&T. Additional details can be found in my Curriculum Vitae, in Appendix A. I am also continuing to submit research proposals.

Also important is the development of a national and international reputation for excellence. I have already begun to develop such a reputation. I have developed a collaboration with Dr. Xuizhong Shen, a researcher at the Kyoto University Research Reactor Institute in Japan. I have been approached by the Institute of Nuclear Safety Systems, a subsidiary of the Kansai Electric Power Company in Japan, to perform funded research on reactor safety analysis codes and model development. As a graduate student I travelled to Japan to train engineers at Mitsubishi Heavy Industries in the use of key instrumentation that I developed for them. I am a member of the Thermal Hydraulics Division of the Atomic Energy Society of Japan, and in March of 2017 I was awarded their Young Member Achievement Award. I have been publishing with international teams of researchers from various countries. I have fielded requests for information and assistance from researchers in various fields and nations. Some examples of email correspondence regarding these requests are included in Appendix B. Finally, my work has been cited by researchers in a wide range of fields and by researchers across the globe. Some selected examples of the works that have cited my publications are included in Appendix C. The fields range from nuclear applications, to the propagation of gas bubbles in volcanic magma, to the development of models for gas-oil flows in oil wells.

![Figure 1: Publications and Citations per Year, 2009-2018](chart)
J.P. Schlegel

Last, but not least, is the mentoring of Ph.D. candidates. As a junior faculty member my first Ph.D. student graduated in May of 2018. One additional student graduated in August of 2018, with three additional Ph.D. graduates expected during 2019.

**DESCRIPTION OF RESEARCH**

*Database Development for Code Validation*

The first step in the scientific method is observation – the collection of experimental data, and a key part of creating new knowledge. Experimental data is also intimately involved in testing hypotheses (models) that are developed to explain those observations. To that end, I have

<table>
<thead>
<tr>
<th>Table 1: Funded Research Activities</th>
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<tbody>
<tr>
<td><strong>Project Title</strong></td>
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<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Overhead Crane Installation and Enhancement of Distance Learning at Missouri S&amp;T Reactor</td>
</tr>
<tr>
<td>Undergraduate Scholarships in Nuclear Engineering at Missouri S&amp;T (2018-2020)</td>
</tr>
<tr>
<td>Radiation Response of Phase Change Materials for Space and Nuclear Applications</td>
</tr>
<tr>
<td>Scholarships in Nuclear Engineering at Missouri S&amp;T (2017-2019)</td>
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<tr>
<td>Scholarships in Nuclear Engineering - III</td>
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<tr>
<td>Improved Drift-Flux Model for Rod Bundles at Elevated Pressures</td>
</tr>
<tr>
<td>Scholarships in Nuclear Engineering - II</td>
</tr>
<tr>
<td>Experimental Validation of Models and Simulations in Nuclear Systems</td>
</tr>
<tr>
<td>Condensation Heat Transfer Experiment and Scaling</td>
</tr>
<tr>
<td>Graduate Fellowships in Nuclear Engineering at Missouri S&amp;T</td>
</tr>
<tr>
<td>Scholarships in Nuclear Engineering</td>
</tr>
<tr>
<td>Code Development for Bubble Coalescence and Breakup - II</td>
</tr>
<tr>
<td>Interfacial Area Transport Study in Gas-Dispersed Flow</td>
</tr>
<tr>
<td>Code Development for Bubble Coalescence and Breakup</td>
</tr>
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<td><strong>Total</strong></td>
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*This funding was obtained while a postdoctoral researcher at Purdue University. A total of $33,000 in funding was transferred to Missouri S&T as a subcontract.
performed a great deal of experimental work over the course of my career. A significant portion of that experimental work has been the collection of an extensive database of bubble behavior – void fraction distributions, interfacial area concentration distributions, fluctuations in the void fraction with time, and other data important to the validation of models in nuclear reactor systems. These experiments have relevance in a wide range of systems. These include:

- Large diameter tubes such as oil wells and vertical risers, chemical processing systems, and vertical risers in natural circulation Boiling Water Reactors.
- Tube bundles such as nuclear reactor cores and steam generators and chemical process cooling systems
- Rectangular channels such as those found in many nuclear research reactors and nuclear reactors for Naval applications

The resulting data has been used by organizations ranging from the U.S. Nuclear Regulatory Commission, Bettis Atomic Power Laboratory, and Chevron Energy Technology in order to validate computer codes. At the NRC this includes validating TRACE, an industry-standard nuclear reactor safety analysis code. Bettis Atomic Power Laboratory has used the experimental data to validate the multiphase flow models in commercial CFD code CFX, produced by ANSYS. Chevron Energy Technology is using data I produced to develop design improvements in their oil processing systems, saving money and improving resource utilization.

I am currently in the process of establishing the Thermal Hydraulics Experiment, Modeling, and Engineering Simulation (THEMES) laboratory at Missouri S&T, highlighted in Fig. 3. Infrastructure necessary for experimental research was recently completed, and I am establishing test facilities for multiphase flow research. The highlights of the THEMES laboratory include

- A 50 hp air compressor capable of delivering up to 207 acfm of compressed air at a pressure of 150 psi;
- A 30 hp centrifugal pump which produces 90 ft of head at a flow rate of 1000 gpm;
- Modular test facility design to reduce construction times;
- Instrumentation including various flow meters, electrical conductivity void probes and electrical impedance void meters, and a high-speed camera capable of recording up to 10,000 frames per second;
- Facilities for testing phase change materials including a Transient Hot Bridge (THB) and high-precision, temperature controlled environments allowing thermal property measurements at temperatures ranging from -5°C to 200°C;
- Access to the Materials Research Center (MRC) at Missouri S&T for advanced materials characterization;
- An existing multiphase flow test facility for rectangular channels.
I also plan to construct a number of unique facilities at the THEMES laboratory. These test facilities include

- A flexible interfacial area transport test facility that will allow the installation of multiple channel geometries, upwards or downwards vertical flow, and testing of advanced instrumentation;
- A facility that uses Sulfur Hexafluoride gas rather than air to perform multiphase flow

Figure 2: Detailed local profiles of phase concentration and interfacial area concentration collected in large diameter tubes
experiments. This gas is much denser than air at atmospheric pressure allowing the evaluation of high-pressure scaling effects without the risks associated with high-pressure testing;

- A liquid sodium test loop for evaluating transport of fission gases during accident scenarios at up to 500°C.
Optimizing and Evaluating Two-Phase Flow Models

The second through fourth steps of the scientific method are developing hypotheses, testing hypotheses, and revising hypotheses. The development, optimization and evaluation of two-phase flow models falls under these steps. As part of this work I have developed new flow regime maps and drift-flux models in large diameter tubes. The publication that resulted from this work, published in 2010, became one of the 10 most-cited papers in the journal Progress in Nuclear Energy from 2010 to 2014. Progress in Nuclear Energy is a Q1 journal in nuclear science and engineering with an h-index of 34. I have also spent time evaluating the prediction uncertainty of the two-phase flow models used in TRACE and RELAP, industry-standard safety analysis codes. As part of this work I developed a revised drift-flux model for the prediction of interfacial drag. The revised model was able to significantly improve the prediction of high void fraction cases in the vertical riser of advanced boiling water reactors, as indicated in Fig. 4. I also developed a new interfacial area concentration correlation by deriving the Sauter mean diameter of both small, spherical bubbles (Group 1) and large Taylor bubbles (Group 2) from the steady state two group interfacial area transport equation. After benchmarking with experimental data, the prediction of interfacial area concentration was significantly improved over current industry-standard approaches, as shown in Fig. 5

Figure 4: Prediction improvement in TRACE: (a) previous model; (b) revised model

Figure 5: New correlation for interfacial area concentration

The centerpiece of this portion of my research over the past few years has been the
development of a modular, one-dimensional two-phase flow analysis code using MATLAB. The graphical user interface for the code is shown in Fig. 6. Based on the two-fluid model used in RELAP and TRACE, I implemented a full two-bubble-group approach with void transport and interfacial area transport. At this time the code is limited to vertical flows without heat transfer, but it is a powerful tool for evaluating models. All of the constitutive models within the code are modular, allowing me to evaluate the sensitivity of the system to changes in the various parameters that are key to accurately predicting multiphase flows.

In the spirit of that effort, I have developed an objective optimization technique for two-phase flow models that uses this code as a key component. Using principles from Pareto optimization and implementing a modified form of the Gauss-Newton algorithm, I was able to make some key revisions to the two-group bubble coalescence and breakup models for large diameter tubes. The resulting model was able to reduce the interfacial area concentration prediction error from 52% to 33%.

I am continuing to use this approach to evaluate the sensitivity of the code to key models. At this time I am focusing on the drift-flux type correlations which are used to calculate the interfacial drag forces, thereby determining the phase concentrations, flow rates, and coolant inventory in nuclear reactor systems. In the near future I will also be evaluating various interfacial area concentration correlation schemes and the addition of void covariance effects in the two-fluid model, a phenomenon which has been neglected until now.

Figure 6: Graphical user interface for two-fluid model code
Advanced Instrumentation for Two-Phase Flows

In the spirit of enhancing the ability of researchers to provide high-quality data for validation of models, I have also been part of the development of advanced two-phase flow instrumentation. As a graduate student I developed a computer-controlled electronic positioning system capable of positioning void probes inside of a flow channel to within 0.1 mm (Fig. 7). Previously, void probes had been positioned by hand using micrometer scales. I then combined this with a multiple-void-probe system and a high-capacity data acquisition system capable of collecting up to 2.5 million samples per second. As a result I was able to perform complex experiments in 15-20 minutes that previously required 3-4 hours.

I am currently working with researchers at Purdue University and Bettis Atomic Power Laboratory to develop a void probe capable of measuring droplets and differentiating them from the continuous liquid in a multiphase flow system. This work is related to the dryout phenomenon, which occurs when the liquid film covering a heated surface completely evaporates. In nuclear systems, this can lead to overheated fuel, cladding damage, and fuel damage. Avoiding this condition requires reliable computer models, which must be validated against high-quality experimental data. To provide these measurements I have been working with collaborators to develop a multiple-sensor electrical resistivity probe, shown in Fig. 8, which is able to measure the droplet fraction, thereby providing data on the fraction of the liquid phase that is available on the heated surface. The probe will be used to collect extensive data under annular flow conditions to assist in code validation.

In addition to the development of the droplet-capable probe, I have been working to develop more robust methods for constructing probes. Typical failure rates for probe construction are greater than 50%, leading to significant losses in both resources and time. Using our in-house electronics facility, I have been working to improve both the construction and characterization process, as shown in Fig. 9. Some key improvements include:

- Use of high-strength dielectric epoxy to coat sensors, with roughened sensor surface to improve adhesion and reduce film draining and beading;
- Soldering the wires to sensors rather than crimping, to reduce breakage and create a
more stable electrical connection;
• Use of a camera-equipped microscope, allowing more accurate measurement of sensor positions through image analysis;
• Storage of images and improving the ability to confirm, review, and repeat data analysis (as compared to handwritten notes).

Figure 9: Improved conductivity probe construction and characterization process

There are also some major concerns regarding the data processing methods used for these types of probes. Specifically, most data processing schemes use the bubble chord length measured by the probe to classify bubbles as Group 1 (small spherical and distorted-spherical bubbles) or Group 2 (Taylor cap and slug or churn-turbulent bubbles). There is a concern that this process incorrectly categorizes many Group 2 bubbles near the size limit as Group 1, since the chord length is often significantly smaller than the bubble diameter. As a result of this and other concerns I have implemented a number of improvements to the data processing software, such as:

• Implemented a moving comparison algorithm rather than a threshold to reduce incorrect grouping of rapidly-following trailing bubbles into one large bubble (see Fig. 10);
• Dynamic voltage ranging using PDFs of raw signals to reduce thresholding errors;
• Signal cross-correlation for initial interfacial velocity identification rather than user-defined input to reduce signal processing time and avoid user errors (see Fig. 11);
• Implement a trust-region method to calculate the diameter of all bubbles previously categorized as Group 1 using a solid-sphere approximation and the interfacial velocity of the front and rear interface to reduce bubble categorization error (see Fig. 12).

The results from the electrical conductivity probes were also compared with measurements performed using optical void probes. Optical void probes were provided by the mREAL laboratory at Missouri S&T, led by Prof. Muthanna Al-Dahhan. Previous studies have confirmed that the total void fraction and interfacial area measurements made using these two sensors agree well, however the bubble group categorization has not been confirmed.
These improvements were implemented and the two data processing methods were compared for a small number of test cases. The data for one test case under pool conditions in a bubble column is shown in Figs. 13 and 14 as a preliminary evaluation of the new method. The new method clearly shows an increase in the number of bubbles counted, indicated by an increase in the total void fraction. This is due to the improved ability of the code to identify trailing bubbles. It should be noted that the void fraction for the conductivity and optical probe is nearly identical in Fig. 14, and that the void fraction measured by the optical probe does not change significantly for the previous and new data processing schemes. This indicates that the new algorithm improves the ability of the code to properly identify bubbles and separate them from electronic noise.

The interfacial area concentration results were surprising. There is an increase in the Group 2 interfacial area concentration due to the inclusion of more bubbles near the cutoff bubble size in Group 2. This reduces the average measured Group 2 bubble size. Due to an improved ability to identify the smallest bubbles, and because the larger Group 1 bubbles have now been moved to Group 2, the Sauter mean diameter of Group 1 bubbles also decreases. Combined with the identification of more bubbles, this leads to significant increases in the measured interfacial area concentration using the new algorithm, as shown in Fig. 13. In Fig. 14, the conductivity and optical probes agree reasonably well for many locations. However the interfacial area concentration measured by the conductivity probe is consistently higher than that given by the optical void probe. This may be due to the higher uncertainty in the interface identification for the conductivity probe, due to the larger rise and fall time of the RC circuit. The results of these two analyses indicate that further analysis of the reliability and repeatability of these measurements is required, and that the updated data processing algorithm may have consequences for coalescence and breakup modeling.

Figure 10: Results of improved interface identification algorithm
Figure 11: Dynamic ranging (left); Velocity cross-correlation (right)

Figure 12: Comparison of categorization by chord length (left) and bubble diameter (right)

Figure 13: Comparison of interfacial area concentration measurement algorithms
Enhancing Passive Safety in Nuclear Reactor Systems

My interest in enhancing passive safety in nuclear reactor systems is driven by the rise of small modular reactor (SMR) systems. These reactors are much smaller, and therefore have much smaller thermal loads. This lends them to various passive safety systems that are impractical in larger designs. One of the most direct applications is the use of Phase Change Materials (PCMs) in SMRs. PCMs are materials that are designed to freeze and melt at a specific temperature, and have a high heat of fusion. This allows them to absorb large amounts of thermal energy at a relatively constant temperature.

In the long term, I plan to develop research on the application of high-temperature PCMs to enhance passive safety in nuclear reactor systems. Some work has already been done in this area by researchers at MIT, who proposed using a large block of PCM to moderate thermal output from a high-temperature gas-cooled nuclear reactor. This system was designed to moderate the electricity output from the reactor and enhance the load-following capability of nuclear reactor systems, and had the desirable side effect of absorbing thermal energy, thereby reducing the temperature of the fuel during accident scenarios. I hope to design PCM systems that change phase at temperatures near 100°C and can be incorporated into the emergency core cooling systems of modern reactor systems. My specific interest is in the suppression pool and reactor containment.

Incorporating PCMs with phase change temperatures in the range of 80 – 90°C in the suppression pool and containment structure has the potential to absorb more heat, reduce the containment pressure, and extend the time during which key safety systems are able to operate.

I began this work by investigating room-temperature PCMs. While this is a first step in a larger

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**Table 2: Key Properties of Eutectic PCM**

<table>
<thead>
<tr>
<th>PCM</th>
<th>$c_{p,s}$ [J g$^{-1}$ K$^{-1}$]</th>
<th>$c_{p,l}$ [J g$^{-1}$ K$^{-1}$]</th>
<th>$T_m$ [°C]</th>
<th>$\Delta h_m$ [J g$^{-1}$]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methyl Palmitate</td>
<td>1.704</td>
<td>2.015</td>
<td>29.06</td>
<td>202.2</td>
</tr>
<tr>
<td>Lauric Acid</td>
<td>2.056</td>
<td>2.045</td>
<td>43.98</td>
<td>180.8</td>
</tr>
<tr>
<td>60MP/40LA</td>
<td>1.513</td>
<td>1.952</td>
<td>25.5</td>
<td>205.2</td>
</tr>
</tbody>
</table>
research program, it also has important potential impacts. Heating and cooling comprises as much as 24% of the energy consumed in the United States each year. The use of PCMs can reduce energy consumption in this area by 30% to 50% [1], reducing energy costs and greenhouse gas emissions. This potential is widely recognized, as evidenced by recent experiments at Oak Ridge National Laboratory [1]. My research team developed a novel eutectic PCM using Methyl Palmitate and Lauric Acid, both naturally occurring fatty acids. The resulting PCM has a melting temperature of 25.5°C and a heat of fusion of 205.2 kJ/kg. Properties drifted by only 1% during 3000 melt/freeze cycles, which represents about 80 years of daily thermal loading and unloading. This temperature range is ideal for heating and cooling applications, and the heat of fusion is as much as 20% higher than other PCMs developed for this application. This PCM may also have applications to space travel: NASA’s ORION mission uses a PCM based heat exchanger to reduce the required radiator size for thermal management. There is also some interest in using PCMs for high-performance computing, storing information using small packets of PCMs as bits (a melted PCM indicates a 1, while a solid PCM indicates a 0). Such systems would be resistant to electromagnetic interference, and may also be resistant to radiation damage.

There are two major concerns associated with this type of PCM. First is leakage of the liquid phase, which causes loss of material and therefore degrades performance. Second is the low thermal conductivity of most organic PCMs, resulting in large thermal gradients that impede the ability of the materials to maintain the internal environment at a constant temperature. To remedy these concerns, two modifications to the PCM were made. First a gelling agent was added. This gelling agent results in a solid-gel phase change and a form-stable PCM that will not leak. Second, graphene nanoplatelets were added to the mixture. These changes had no effect on the melting temperature, but reduced the energy storage capacity to about 180 J/g and increased the thermal conductivity by 100% as shown in Fig. 15. Further, the addition of nanoparticles reduced the supercooling typical of organic PCMs by providing nucleation sites for freezing to begin. This reduces the difference between the melting and freezing temperatures, improving the temperature management capability of the PCM.

![Graph showing Improvement in thermal conductivity and reduction in superheat/supercooling through PCM modification](image-url)
Recently, my research team investigated the properties of higher-temperature PCMs. Octadecanoic acid, commonly called stearic acid, was identified as a promising PCM for steam condensation in nuclear applications. Unfortunately there were some key problems in the available literature due to a lack of consistent product quality among manufacturers. Recent processing improvements resulting in much higher purity have now allowed us to characterize octadecanoic acid as a PCM using high-precision techniques. The melting and freezing temperatures were determined to be 69.5°C and 65.5°C, with latent heat of fusion of 221.2 J/g. This makes the material very promising. Additional detailed characterization of the thermal conductivity, specific heat, and thermal diffusivity have also been performed and are detailed in Fig. 16.

Over the next two years I plan to expand into several key areas for expanding the use of PCMs in energy efficiency, nuclear reactor safety, and space exploration:

- Alternative eutectic PCMs, which have the potential for heats of fusion as high as 250 kJ/kg;
- Integral testing to evaluate the effect of PCMs on containment pressurization during loss of coolant accidents in nuclear reactors;
- Use the Missouri S&T Reactor to investigate the response of PCMs to radiation damage, key for evaluating the suitability of PCMs for nuclear reactor safety and space exploration applications;
- Incorporating form-stable PCMs in structural concrete by mixing with the mortar to improve energy efficiency of residential and commercial buildings with Dr. Kamal H. Khayat, advanced concrete expert and director of the Center for Infrastructure Engineering Studies at Missouri S&T.
- Incorporating form-stable PCMs into roads and bridges to prevent freezing, improving safety by preventing ice formation on the roadway and reducing freeze/thaw damage.
Applied Research on Two-Phase Flow Phenomena

In addition to fundamental scientific and engineering work, I have been involved in a number of important applied research projects for a variety of sponsors. During work for Mitsubishi Heavy Industries on the design of a chemical scrubber for flue gas from coal power plants I created a dynamic solver for droplet behavior. The solver was able to calculate the droplet fraction and determine the conditions for which instability due to counter-current flow limitation would occur, allowing MHI to avoid these conditions and optimize their final design. This led to additional work from that sponsor, including the development of an impedance void meter capable of quickly evaluating the symmetry of the void fraction profile in a pipe. That work included the design and construction of a scale model system, experimental validation of the measurement principle, and construction of a full-size prototype 30 cm in diameter. At the culmination of the project I travelled to their testing facility in Japan to assist in the installation and calibration of the instrument and train several of their engineers in its use. The technology was used to evaluate the effect of upstream conditions on pump degradation due to void ingress, leading to better guidelines for designing and operating emergency core cooling systems in nuclear reactor systems.

That project was closely related to work that I did for Westinghouse Nuclear.

Figure 16: Recently characterized properties of octadecanoic acid as a PCM
2008-1 (US NRC) highlighted air ingress in emergency core cooling systems as an issue that needed to be urgently addressed. Over three years I worked on the design, construction, and testing of four scaled experimental facilities designed to mimic the behavior of emergency cooling pump systems with diameters of 0.1 to 0.3 m. The test facilities included clear visualization ports, high-speed video capture, and detailed void fraction measurements at various points along the suction piping for the pump. The results were used by Westinghouse Nuclear to justify the safety of the systems to the NRC.

More recently I was the PI on a project for the Institute of Nuclear Safety Systems (INSS), a subsidiary of the Kansai Electric Power Company in Japan. This project involved significant literature search, evaluation of existing data regarding the boiling of water in nuclear reactor cores, evaluation of the sources of the data and the associated uncertainties, and the recommendation of a transition model for moderate pressures – from 0.5 to 5 MPa, to bridge well-known conditions at nearly atmospheric pressures and at full-pressure operating conditions of 7 to 15 MPa. This moderate-pressure region is important for the prediction of certain portions of small-break loss of coolant accidents, but very little experimental data is available in that region. INSS implemented the resulting model in their custom version of RELAP5 and is currently evaluating the recommended model against the data available in the scientific literature.

I am also a co-PI on a project for the Small Modular Reactor Research and Education Consortium (SMRrec). This project involves the design and construction of a test facility to investigate scaling effects on condensation heat transfer in SMR passive cooling systems. The Passive Containment Cooling System (PCCS) is one of the most important passive safety systems used in small modular reactors (SMRs). The containment vessel (CV) forms an integral part of the PCCS system. At the time an accident is initiated, steam is released from the Reactor Pressure Vessel (RPV) into the CV. This steam condenses on the CV walls. This leads to condensation heat transfer from the RPV steam to the containment wall. The condensate is returned to the reactor core through drain lines. It is well documented that the presence of even a small quantity of non-condensable gases (NCGs) greatly influences the condensation process. Research in the COndensation Rate for Passive Safety (CORPS) test facility aims to study the characteristics of heat transfer of a PCCS in the presence of non-condensable gases. Specific objectives for this research are:

- Review and evaluate existing data and models for condensation heat transfer for application to Westinghouse SMR (W-SMR) containment condensation
- Perform experiment and CFD simulations to evaluate the scalability to predict condensation heat transfer with and without NCGs.
- Evaluate and validate the effectiveness of the CFD simulations in scaling of condensation phenomena for different diameter pipes

The experimental facility consists mainly of a steam supply, a condenser (test section), and a nitrogen supply as shown in Fig. 17. The steam from the steam supply is throttled to the appropriate pressure for an experiment. Then it is mixed with a small amount of nitrogen, a non-condensable gas. The mixture then runs through a pre-cooler to return the steam to a saturated
state. The entrance pressure and temperature are measured, then the steam condenses within the test facility. Condensation heat transfer rates are calculated by measuring temperature changes. Afterwards the condensate and any remaining steam are mixed with additional cooling water and the mixture exits the system to the drain. The test section is a concentric pipe system that will be used to condense the saturated steam from the boiler. The outer jacket will have cooling water flowing through it to remove heat from the steam. Thermocouples will be placed at multiple locations to measure the temperature increase in the cooling water and the wall temperature in order to calculate the condensation heat transfer rates and heat transfer coefficients.

![CORPS facility schematic and isometric view](image)

**Figure 17: CORPS facility schematic and isometric view**

The experiment will be compared with CFD predictions generated using STAR-CCM+. The geometry model for CFD simulations is a simple concentric tube heat exchanger. Models were created in SOLIDWORKS and imported into STAR-CCM+. A steam/vapor mixture is modeled on the inside of the steel tube as shown in Fig. 18. The steam was divided into an adiabatic upstream region and downstream region. The upstream adiabatic region is where flow development takes place, while the CFD analysis of heat transfer is performed only in the downstream region. A 3D volume mesh separating the steam-steel-water interface was created using the region based meshing approach in STAR-CCM+. Mesh independence tests confirm that base size of 0.226 inches is the best suit for this study.
Simulations are performed by two different methods. First is an iterative study to individually simulate both the steam and cooling water regions. The second method was a combined simulation of both water and steam/vapor region with conjugate heat transfer between them. It was observed that for both the iterative and combined study, the software acceptably predicts the general trends of temperature distribution at various axial and radial locations, as shown in Fig. 19. A maximum error of 18% was found in the predictions of water adiabatic wall temperatures. The error reduced with the axial location to a minimum of 5.9% at 1.45 meters from the steam inlet. Errors in the prediction of heat transfer coefficient were much more significant, as they ranged from 68% near the inlet to 38% at a location 1.45 meters downstream of steam inlet. This can be attributed to the heat flux calculation method adopted by the software. Specifically the nucleation site density for condensation is a user-input parameter that has significant effects on the calculated heat transfer rate, however little to no guidance or framework exists for modeling or selecting this parameter. This shortcoming limits the ability of STAR-CCM+ for predictive design calculations, where the nucleation site density is not known a priori.
Cited Works:

TEACHING AND MENTORING

TEACHING PHILOSOPHY

I would begin this section with a disclaimer: this is less of a teaching philosophy than it is a learning philosophy. After all, we do not evaluate faculty on how much they teach, but on how much their students learn. Those of us from academia have a long history of learning – and should therefore have a great deal of experience to draw upon. One of my best experiences as a learner was in my high school calculus and physics courses. Both courses were taught by the same person. What I remember most about those classes was the sense of discovery – the ‘aha!’ moments that occurred throughout the class. I realize now that those moments were the result of his careful planning – that he guided us toward the answer almost without us realizing that we were being directed. That is what I hope to be able to do for my students, and I think that the students have gotten that message. Many of my student comments include some variation of “The most kind and caring professor I have ever had. He truly wants all of his students to succeed.”

To move the students toward that ‘aha!’ moment, it is important to keep in mind the purpose of teaching. Why do we want to pass on what we know? The answer seems obvious, but is often lost in the noise of developing lesson plans, educational activities, and assessments. To me, the purpose of teaching is to

1. Help students understand the concepts and ideas behind the equations and the real-world meaning of the facts that they can read in their textbooks,
2. Give them the ability to bring together the pieces of their education and understand how they work together to describe real processes,
3. Show them how to use their existing knowledge and critical-thinking abilities to develop new ideas, and
4. Instill in students a passion for learning and discovery.

These four goals should be the measuring stick for our success or failure as educators. Of course, how to go about achieving those goals is another matter entirely. I believe that people tend to rise or fall to the level that is expected of them. I will admit to having very high expectations of our students, but I have found that once the students understand what those expectations are many of them rise to the challenge. I also believe that treating them like adults, with honesty and high - but realistic - expectations, allows them to treat themselves like adults and take the responsibility for their performance on themselves. One of my students commented “Very tough, made me push hard to earn a grade.”

There are some basic principles that I believe are very important to any attempt at education. The first principle is that teaching is essentially a form of communication. In fact teaching could be considered a form of performance art. Vocal inflection, body language, humor – all of these factors communicate information to your audience above and beyond the words you use. A good educator uses these nuances of communication to convey passion and excitement for the topic along with the course material. I always make an effort to be an active speaker, moving around
the room, varying inflection, and so on. I also incorporate a little bit of humor into my lectures – sometimes you also need to be able to accept and understand that your own mistakes can help students connect with you. If you don’t take yourself too seriously, are willing to admit those mistakes, and ask the students to show you where you went wrong. This approach can be seen in the student comments in Appendix E, such as “Invests the time to cover examples in detail. Works clearly and easy to follow. Good communicator,” and “Dr. Schlegel was willing to improve on his teaching skills and in the way he taught constantly, which was one of his biggest strengths.” It is also important to relate your lessons to the other lessons in the course, to applications in industry, and to one’s own research experience. This helps keep students interested by showing them how the material they are learning has real-world applications and uses, and helps them to remember the information by connecting material to a memorable story or event as well as other important subjects. I have been working to improve this in my courses, and the students have noticed: “Keep doing examples. They were great!”

Second, student participation is essential to learning. It requires the student to absorb and process the information immediately, rather than passively listening and writing notes. Encouraging questions and in-class activities that focus student attention keeps them engaged and helps promote independent thinking. That is why I am moving to team-based learning in the courses I teach – to promote discussion and critical thinking, and to allow for more active instructional techniques to increase engagement. I enjoy working together with the students to find answers using leading questions and suggestions rather than telling them the answer, and the students appreciate the experience. One student said “As much as the students may not like it, you should force participation in class...” The use of information technology in the classroom can also be helpful to disseminate information, and promote peer interactions via discussion boards, thereby encouraging students to find answers from their peers rather than from persons of authority.

Third, students must have the opportunity to apply what they learn. For this reason I am also beginning to apply problem-based teaching techniques in the classroom. I use real-world examples, then have the students work in teams to come up with a recommendation to solve the real-world problem using the material we are discussing in class. I also use open-ended or forward-looking questions in homework assignments and exams to encourage critical thinking rather than rote memorization and to remind the students of the real-world implications of their classroom instruction.

Finally, we need to remember that learning should be fun. Learning is exploring the world around us in new ways. It is our responsibility to show students that even after decades of working in our fields we still enjoy our work and continue to discover new and interesting things.

During my time at Missouri S&T I have spent a lot of time trying to learn the best ways to achieve this goal. Participating in activities like the Freshman Faculty Forum, University of Missouri Faculty Scholars, Curators’ Teaching Summits, and many other discussions on campus, as well as reviewing key literature, has been very helpful in this regard. Being exposed to the idea of the VARK learning inventory (Marcy, 2001) was a powerful experience for me, and I began using it to design more varied instructional activities that would appeal to various learning styles.
I also have the students fill out the inventory and learn more about their learning styles on the first
day of class, which helps them develop study strategies for their other classes as well. More
exposure to learning theories such as *Bloom’s taxonomy and the Depth of Knowledge* chart
provided me information that has allowed me to target assignments to the skills and knowledge
that I want the students to take out of my classroom. One thing I have struggled with during my
first years as an instructor is keeping students engaged with the material, as evidenced by some of
the student comments in Appendix E. My introduction to *team-based learning strategies*
(Michaelson et al, 2004) has given me a new tool that I think will significantly improve student
engagement in the classroom – I implemented team-based class examples, and in-class work in
my courses over the previous two years. I regularly solicit feedback from the students, and I have
tried to incorporate many of those suggestions as *mid-semester course corrections*. I also solicit
less formal feedback during LEAD sessions and during individual discussions with students.
These activities have also provided some valuable advice and suggestions.

- Marcy, V.  Adult Learning Styles: How the VARK learning style inventory can be used to improve
- Michaelson, L.K., A.B. Knight and L.D. Fink. Team-based learning: a transformative use of small

**TEACHING RESPONSIBILITIES**

At Missouri S&T my teaching responsibilities varied somewhat during my first few semesters.
As a result, I taught seven different classes over my first seven semesters at Missouri S&T. At
this point my course load has stabilized and I am typically responsible for four classes each year:
Reactor Fluid Mechanics (NUC ENG 3221), Reactor Heat Transfer (NUC ENG 3223),
Introduction to Nuclear Thermal Hydraulics (NUC ENG 4257/5257) and Advanced Nuclear
Thermal Hydraulics (NUC ENG 6257). I have also begun teaching a professional development
course for sophomores (NUC ENG 2001), and am developing NUC ENG 5281 (probabilistic risk
analysis) to alternate with teaching NUC ENG 6257. The syllabi for these courses can be found in
Appendix D. I am also co-teaching the capstone design courses, NUC ENG 4496 and NUC ENG
4497, with two other faculty. My overall effectiveness scores for these courses, grouped into
Junior Required Courses, Senior Technical Electives, and Graduate Courses, can be found in
Figure 20. My evaluation scores have been consistent and positive for senior level electives and
graduate courses. Among the positive comments during my first two semesters were (a more
complete list of selected comments can be found in Appendix E):

- “Excellent knowledge of material and availability outside of class.”
- “The instructor is *very passionate* about the material.”
- “*Very hard working and cares about his students.*”
- “Willing and *excited to learn how to teach*”

However there were also some constructive criticisms:

- “There was no hands-on realization on the subject matter.”
- “*Inexperienced* in teaching practices, and different learning styles.”
• “The fact that he knows the material so well causes him to skip explanations of intermediate steps.”
• “Less test, more projects!”

Last year I implemented a new teaching method using team-based learning to focus more on concepts that are difficult to learn from simply reading the textbook. Since this was a first experience with the method for both me and my students, the results were mixed and my reviews in NUC ENG 3223, taught each Spring, were poor. I took advantage of student feedback and a reduced teaching load in Fall 2017 to modify the teaching method. Lectures were pre-recorded and made available online. In-class time was spent reviewing and solving example problems and addressing questions the students had regarding the online lectures. This allows the inclusion of more forward-looking, in-depth homework assignments. As a result, my teaching overall effectiveness score increased from 1.7 to 2.9. One student commented:

• “Since last semester, Dr. Schlegel has improved his teaching methods significantly … he is clearly making progress. He constantly asks for feedback … implements a correction to his methods promptly.”

Overall I believe that my efforts have been successful and that the students have learned. Several students commented that the material they learned was very valuable to them:

• “It’s a great class to prepare us for real world problems.”
• “This course is difficult, requiring a lot of focus and studying. However, the educational payoff through understanding is immense.”
• “I felt that the course held a LOT of very important and vital information.”

While my evaluation scores dropped after implementing the new course format, they rose quickly as I made adjustments and the students become more familiar with the new course structure. I plan to continue to be responsive to student comments and suggestions.

Course Descriptions

NUC ENG 2001: Professional Development for Nuclear Engineers

This course focuses on professional development and skills that students will need to succeed in their courses. The first module focuses on employment-related skills including resume and cover letter development, the interviewing process, etc. The second module focuses on writing
lab reports and other technical documents in engineering courses and the preparation and delivery of technical presentations. The final module of the course focuses on (1) developing a consistent, logical problem solving process, and (2) using numerical methods to solve problems in Excel and Matlab, including iterating implicit equations and discretizing differential equations.

NUC ENG 3221: Reactor Fluid Mechanics
This course is an essential fluid mechanics course focused on teaching fundamental concepts and applications in fluid mechanics with a focus on nuclear reactor applications. The course is taught using a team-based approach that emphasizes critical thinking, translating problem statements into mathematical models, and engineering decision-making. Typically this course includes 35-40 students and is divided into five modules. Each module includes an introductory reading test, various team activities, individual homework, and an exam. Team activities are the focus of in-class time, while students are expected to obtain fundamental concept knowledge from the textbook and from short tutorial videos prepared by the instructor and posted on a YouTube channel.

NUC ENG 3223: Reactor Heat Transfer
This course is an essential fluid mechanics course focused on teaching fundamental concepts and applications in fluid mechanics with a focus on nuclear reactor applications. The course is taught using a team-based approach that emphasizes critical thinking, translating problem statements into mathematical models, and engineering decision-making. Typically this course includes 35-40 students and is divided into five modules. Each module includes an introductory reading test, various team activities, individual homework, and an exam. Team activities are the focus of in-class time, while students are expected to obtain fundamental concept knowledge from the textbook and from short tutorial videos prepared by the instructor and posted on a YouTube channel.

NUC ENG 4496: Nuclear Systems Design I
A capstone design course focused on combining knowledge from various specializations in nuclear engineering to prepare a design proposal for a nuclear system. Generally includes discussion of engineering ethics, engineering decision making, and engineering optimization. At the end of the course students prepare a preliminary design proposal and present their proposal to the class. Typically this course includes 35-40 students. This course was recently changed to a co-teaching format where multiple faculty share responsibilities in order to provide a wider range of expertise to the students.

NUC ENG 4497: Nuclear Systems Design II
The second semester of the capstone design course focused on combining knowledge from various specializations in nuclear engineering to prepare a final design report for a nuclear system. Content is focused on the various steps in the design process and is generally flexible to allow for variations in the needs of the design teams. At the end of the course students prepare a final design report and present their design to the class. Typically this course includes 35-40 students. This course was recently changed to a co-teaching format where multiple faculty share responsibilities in order to provide a wider range of expertise to the students.
NUC ENG 4257/5257: Introduction to Nuclear Thermal Hydraulics
An introductory course for students interested in the application of fluid flow and heat transfer to nuclear reactor systems. Students will learn the fundamentals of the scientific method in engineering and review fundamental principles of mass, momentum, and energy transfer in nuclear systems. Modeling of single-phase flows and applications to energy systems will be discussed, as will fundamentals of heat transfer in nuclear fuels and reactor systems. The fundamental challenges of two phase flows and the field equations will be introduced with examples. Mixture properties and models, void fraction correlations, and pressure drop correlations for two-phase flows will be introduced, followed by a discussion of boiling and condensation. Typically includes 5-15 students.

NUC ENG 4281/5281: Probabilistic Risk Analysis I
An introductory course on probabilistic risk analysis in the nuclear industry. Students will discuss how risk is defined, used, and communicated in nuclear applications. The mathematical methods, empirical data, and other techniques necessary for computing risk will be analyzed, and students will learn how important parameters such as Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) are computed (Level I PRA). Students will be briefly introduced to calculations of radioactive release (Level II PRA) and consequences of radioactive release (Level III PRA).

NUC ENG 6257: Advanced Nuclear Thermal Hydraulics
Detailed treatment of advanced topics in nuclear thermal hydraulics including a brief introduction to PRA, fuel melting and severe accident scenarios, two-fluid modeling and interfacial area transport, counter-current flow limitation and flooding, etc.

Professional Development
In response to concerns among Nuclear Engineering students about professional development and job searching, I established a series of professional development lectures. These lectures are open to students across campus, but focused on Nuclear Engineering. The content is intended to correct common misconceptions and to address common issues for undergraduate and graduate students. Current seminar topics include resume development, writing a CV, job interviewing skills and how to critically read journal papers. Additional topics will be forthcoming in the next two to three years. Starting in Fall 2017, I have presented several workshops. Some comments from the students that attended these workshops included:

- “It’s very valuable and I really learned a lot from you. Actually, I messed up my first interview, and I realized some of my problems according to your presentation, which I will try to improve in future interviews.”
- “You did a great job. It was a very impressive and informative presentation. I hope CGS will continue this type of important event.”
- “I enjoyed the presentation and thought the information you shared was very valuable.”

I continue to offer seminars for graduate students and student organizations.

UNDERGRADUATE AND GRADUATE MENTORING
The mentoring of graduate and undergraduate students is a key component of our efforts as
A detailed list of my undergraduate and graduate student supervision can be found in my Curriculum Vitae in Appendix A. To summarize, I have supervised two undergraduate researchers and plan on involving many more in research over the next few years. I have had two students complete a MS, and one of those recently obtained a Ph.D. An additional student also recently completed a Ph.D. I am advising or co-advising seven students in their PhD study. Three more Ph.D. students should complete their degrees in the next 12 months. In addition, I have served/am serving on the advisory committees of 4 graduate students.

I have an open-door policy – any time I am in my office the door is open, and students can stop in to discuss issues they are having with coursework, research challenges, or if they just need some professional advice. I make sure to work with students on not only their scientific and technical skills, but also their professional development and communication skills. I hold group meetings for all of my graduate students every week to keep everyone updated on current research, progress, and goals. I assess the students each semester, and share the results of the assessment (including recommendations for addressing weaknesses) with the students. Finally, I emphasize the need for clear communication. I expect students to present to their peers at least once prior to defending their dissertation through our department graduate seminar, and work closely with them on writing the presentation and on their delivery skills. I also expect students to prepare manuscripts for publication, and take them through the process step by step from determining objectives and preparing an outline to writing the various sections and developing clear conclusions. I encourage students to attend grant-writing workshops, then involve the students in helping me prepare proposals for funded research.
SERVICE

SERVICE PHILOSOPHY

Many faculty treat service as an obligation to be avoided. As junior faculty we are often told to focus on research and teaching – that service is somehow less important. I disagree with this view. Service should be just as forward-looking and strategic as research and teaching, if not more so. Service is a great way to increase visibility and make an impact on the future of the discipline, university, and department. It is a way to build strong professional relationships and develop partnerships. It is a vehicle for sharing knowledge and creating ideas.

This outlook on service has been developed over a long time, but one of the most influential factors in this process was the time I spent in the Boy Scouts. Service was a strong component of my troop’s activities. In the process of earning the Eagle Scout award planning and carrying out service activities is a major component. When I was going through that process I wanted to make sure that my service activity would have an impact – even if no one really knew about my involvement. That attitude has carried over into my professional career, as evidenced by my many service activities as a graduate student. A list of these service activities can be found in my Curriculum Vitae in Appendix A. This culminated in an Outstanding Service Award from my alma mater, Purdue University.

Since arriving at Missouri S&T I have worked to continue that record. I have requested committee assignments that put me in a position to have a positive impact on the future of my department. Professionally, I have actively sought out reviewing assignments and been an active participant in highly visible professional conferences. These assignments will be detailed in the next few sections.

DEPARTMENTAL AND INSTITUTIONAL SERVICE

As stated above, my departmental and institutional service has been focused on areas that will allow me to have a positive impact on the future. Some of this service includes things as basic as meeting with prospective students or developing courses. In addition I have initiated some activities that do not fall under a committee – such as a review of the number of students, number of faculty, and key productivity measures for high-ranking Nuclear Engineering programs. The hope is that this process will help us identify areas that we can address to improve our impact and visibility. I make sure that I am available to help other committees when necessary and strive to be involved in departmental concerns and development. Much of this work is integrated with my every-day teaching and research activities, however I would like to take this opportunity to address a few key areas:
Undergraduate Program Coordinator

I currently serve as the Nuclear Engineering Program Curriculum Committee chair and as the Undergraduate Program Coordinator for Nuclear Engineering. In this position, I work closely with the staff advisor for our undergraduate students and am responsible for our ABET preparedness. This process can be challenging at times. Working to find a way forward for students who have struggled during their first semesters or students who came to Missouri S&T without the necessary background in mathematics can be both trying and time consuming. But it is also very rewarding. Seeing those students get back on track and watching them succeed – and knowing that I was a part of that – is very gratifying.

As part of this effort I was asked to work with Educational Technology to create a short introductory video. After discussing their intent with the Freshmen Engineering Program and meeting with EdTech I prepared a script and worked with them to record the video, which they then edited. I also suggested that Educational Technology get in touch with several current and former students for short interviews. I suggested a list of possible students and interview questions. The result was a short video of students giving their perspective on the Nuclear Engineering Program – a perspective that incoming Freshmen should find very valuable. The videos were so successful that the Program Chair for Nuclear Engineering is adding them to the program web page.

Department Committees

I have also been serving on a number of key department/program committees. The list of these committees can be found in Appendix A. Again, the selection of these committees reflects my conviction that service should be forward-looking and strategic.

One of the first committee assignments I requested was the Nuclear Engineering Program Curriculum Committee. This is the committee that reviews our student feedback and ABET metrics each year and recommends changes to continuously improve the curriculum. As part of this committee I completely re-designed our senior exit survey after reviewing the exit surveys of various other departments within the university and nuclear engineering programs at other universities. The new survey gives us a much better idea what our students did and did not like about their experience and provides additional data regarding key ABET metrics. This committee assignment also gives me the ability to suggest and argue for changes that I think are necessary to keep our program competitive in the national and global market. As a result of my efforts I was asked to serve as committee chair in Fall of 2016, a post I accepted.

I also requested to be assigned to the Nuclear Engineering Steering Committee, which was charged with updating the program strategic plan. In the program’s previous strategic plan, last updated in 2010, one of the key goals was to reach 160 students by 2020. We achieved that goal in 2015, reaching a total of 164 students that year. Due to our program’s strong growth during that period new challenges have arisen. Thus the steering committee was asked to take a fresh look at the program’s situation and develop new goals for the next five to ten years. That process has been complicated by the hiring of a new chair for the Department of Mining and Nuclear Engineering, a new Dean of the College of Engineering and Computing, and the process of finding
a new Chancellor, and is therefore ongoing.

On that note, I also requested to be assigned to the search committee for the Mining and Nuclear Engineering Department Chair. I viewed this as a key opportunity to have *a strong voice in the selection of the individual who will lead our department* for the foreseeable future. It was a valuable learning experience. I was able to see first-hand many key university functions and meet a number of interesting people. I hope that *some of the candidate interviews may lead to future research collaborations*. The committee members had some very valuable discussions on ways that the Mining Engineering, Explosives Engineering, and Nuclear Engineering programs can work more closely together in research, teaching, and service.

In the next several years I *plan to continue this strategic selection* of service activities in order to continue to have an impact on the Nuclear Engineering program, our department, and the university.

**PROFESSIONAL SOCIETIES AND JOURNALS**

Service in professional societies and journals is one of the *most effective ways to increase personal and institutional visibility*. Professional organizations and conferences provide the opportunity to present your work, receive feedback from other experts, share knowledge, and build collaborations and partnerships.

*Journals*

I am an *active reviewer for 15 professional journals* related to nuclear engineering and multiphase flow. Over the last two years I have *completed 20 reviews for those journals*. This has given me the chance to *review current research* in my field, get ideas for research topics, and *identify possible collaborators*. In addition to this, it has allowed me to *establish myself in an expert in the field* with valuable viewpoints. This is illustrated by the review request I have included in Appendix B, which identifies me as a “world leading expert in this technical area” and acknowledges my previous review activity.

*Professional Societies and Conferences*

I am an active member of both the American Nuclear Society and the Atomic Energy Society of Japan. The American Nuclear Society is the premier professional organization for those involved in nuclear science and technology across the world, and sponsors multiple professional conferences each year. I am a member of the Thermal Hydraulics Division, which focuses on thermal-fluids research and teaching, and the Young Members Group, which is composed of those who have received their terminal degree within the last five years. This membership has helped me *maintain contacts* with the various students and professionals that I have met and worked with as a graduate student, postdoctoral researcher, and faculty member. I joined the Atomic Energy Society of Japan due to my strong research collaborations in that country, including previous work with Mitsubishi Heavy Industries, the Kyoto University Research Reactor Institute, and the Institute for Nuclear Safety Systems. This has allowed me to *keep up on key research* across all
specialties of nuclear engineering and has helped strengthen those research ties.

I have also been active in professional conferences. Over the last few years I have served as a reviewer for six conferences, reviewing 12 manuscripts. I attended two of those conferences and served as a session chair during NURETH 16, one of the most popular conferences on nuclear reactor thermal hydraulics in the world, with representatives from Japan, China, India, South Africa, and many European nations. In the future, I plan to increase my activity within the Thermal Hydraulics Division of the American Nuclear Society.

**SERVICE TO THE COMMUNITY**

Community service is an often-neglected component to professional service, but it is also important due to its uniqueness. Community service allows us to work with other members of the community – people we would not generally meet during our professional work. It allows us to spread the discussion of our research and educate people who are not experts in our field and – truthfully – may not be technical professionals at all. It allows faculty to increase their visibility in the community and build up the reputation of the university and the departments, and it allows faculty to pursue interests outside of their research and teaching.

For my part, I have long had an interest in theater. This is partly why I often view teaching as performance art. I have volunteered to serve community theaters in a technical capacity, as master electrician and lighting designer, for a number of years prior to moving to Rolla. During that time I set up lighting for five major musicals and at least a dozen more minor shows. For one of those musicals and three of the minor shows I was also the lighting designer, planning how each scene of the show would be lighted to produce the desired emotional and dramatic effect for the audience. I found both experiences to be extremely rewarding. I recently starting serving as a lighting designer and technician at Christian Life Church in Rolla.

I have also had the opportunity to serve as a volunteer coordinator for HorrorHound Weekend. HorrorHound Weekend is a convention held twice each year, in Indianapolis, IN and Cincinatti, OH, to celebrate thriller and horror movies. Actors from various films and franchises are invited, along with special-effects artists, directors, and other professionals. People from all walks of life attend to meet celebrities and have fun. As part of the show my responsibility was to schedule volunteers at the various duty stations and make sure they got there, then make sure that they had the resources they needed to do their jobs. The experience was a lot of fun for me.

Through these admittedly unique activities, I was able to learn a great deal about performance and met many interesting people. And of course, when they found out that I was a nuclear engineer, I had the opportunity to discuss my field, my research and the university with those people. Unfortunately I have not had the opportunity to continue these efforts over the last year for personal reasons, however in the next two to five years I hope to renew my involvement in these activities.
APPENDIX A – CURRICULUM VITAE

Joshua Paul Schlegel
Assistant Professor
Department of Mining and Nuclear Engineering
Missouri University of Science and Technology
Email: schlegelj@mst.edu
Web: nuclear.mst.edu; https://www.linkedin.com/in/schlegeljp;
https://www.researchgate.net/profile/Joshua_Schlegel

226 Fulton Hall, 301 W 14th St
Rolla, MO 65409-1070
Phone: 573.341.7703
Fax: 573.341.6309

SUMMARY
I am a professor in Nuclear Engineering specializing in nuclear reactor thermal hydraulics, or the motion of fluid and energy in nuclear reactor systems. I work extensively on two-phase flows including interfacial area transport and bubble hydrodynamics and am branching out into exciting new areas such as phase change materials and passive safety systems. As an instructor, I am working to bring a more hands-on approach to the classroom through problem-based, team-based learning techniques and am working to develop a laboratory course on thermal-fluids with laboratory activities based on ongoing research.

EDUCATION
Ph.D. in Nuclear Engineering, Purdue University (December 2012)
Thesis Title: Multidimensional Two-Phase Flow in Large Diameter Systems
Advisor: Distinguished Prof. Mamoru Ishii
M.S. in Nuclear Engineering, Purdue University (May 2009)
Thesis Title: Experimental and Analytical Study of Relative Velocity and Drag Force in Large Diameter Pipes
Advisor: Distinguished Professor Mamoru Ishii
B.S. in Nuclear Engineering, Purdue University (May 2007)

CURRENT POSITION
Assistant Professor, Undergraduate Coordinator, Department of Mining and Nuclear Engineering, Missouri S&T
(March 2014 – Present)
- Educating the next generation of nuclear scientists and engineers
  - Revised and reformatted Reactor Fluid Mechanics (NUC ENG 3221) and Reactor Heat Transfer (NUC ENG 3223) to implement team-based and problem-based teaching methods
  - Pushed the inclusion of additional instruction and industry involvement in Nuclear Systems Design I/II (Nuc Eng 4496 and 4497)
  - Established professional development seminar series for Nuclear Engineering students
- Researching solutions to thermal-hydraulics challenges in a variety of systems
  - Established of Thermal Hydraulics Experiment, Modeling, and Engineering Simulation (THEMES) laboratory at Missouri S&T
  - Developed a new, modular two-fluid model code development with interfacial area transport to investigate bubble coalescence and breakup and other key thermal-hydraulic phenomena
  - Developing of advanced, droplet-capable electrical resistivity probes
  - Measuring and modeling condensation heat transfer in Small Modular Reactor (SMR) safety systems
  - Developing and assessing phase change materials for nuclear and commercial applications
- Ensuring excellence in the undergraduate program
  - Overhauled monitoring of ABET performance criteria and continuous-improvement process
  - Initiated review and overhaul of academic program

OTHER PROFESSIONAL EXPERIENCE
Consultant
- Thomas Edison State University – College equivalency review for Reactor Operator and Senior Reactor Operator licenses
Postdoctoral Fellow, School of Nuclear Engineering, Purdue University (2012 – 2014)

- Obtained over $700,000 in total funding for experimental research
- Developed and implemented a rigorous review program for external reports
- Managed and advised several teams of graduate students; guided graduate students through the submission of five papers to refereed journals
- Developed dynamic solver for interfacial area transport and void transport equations, coupled with prediction of pressure drop and gas velocity based on the two-fluid model
- Directed development of droplet-capable conductivity probes for local measurements in annular flow

GK-12 Teaching Program (August – December 2011)

- Learned to manage a classroom with a middle school teacher, progressing to co-teaching and independently teaching the class based on lesson plans prepared by the teachers
- Created a lesson plan related to field of study and used lesson plan to teach a class

Graduate Research Assistant, School of Nuclear Engineering, Purdue University (2007 - 2012)

- Modeled new flow regime transition criteria and drift-flux constitutive relation for large diameter pipes to improve void fraction prediction in TRACE code (US NRC), updated previous models for interfacial area transport in large diameter pipes
- Designed new crossed-wire impedance meter as an inexpensive, rapid alternative for evaluating the symmetry of two-phase flows. Travelled to Japan to train sponsor engineers in the use of the instrumentation (Mitsubishi Heavy Industries)
- Implemented a high-speed multiple-probe technique for reducing the measurement time required for interfacial area concentration measurement using conductivity probe methods, including the use of advanced computer-controlled positioning systems and high-data-rate acquisition circuitry

Undergraduate Laboratory Assistant, School of Nuclear Engineering, Purdue University (2006 – 2007)


Resident Assistant, Tarkington Hall, Purdue University (2006-2007)

- Supervised a floor of 46 undergraduate students
- Created, planned, and implemented educational and social programs for residents
- Couseled students on academic an personal concerns
- Managed administrative duties including maintenance requests, incident reports, and room condition reports
- Enforced Residential Life rules and regulations to ensure a safe and enjoyable environment for living and studying

Student Supervisor, Pappy’s Sweet Shop, Purdue University (2004-2006)

- Led shifts of up to 8 student workers; assigned duties and tasks and ensured satisfactory completion
- Addressed customer complaints and concerns
- Ordered necessary supplies
- Developed high-efficiency stocking system that allowed me to manage the entire kitchen alone on evenings and weekends

Student Worker, Hilltop Apartments (2005-2006)

- Oversaw all landscaping activities
- Performed minor maintenance on university-owned apartments
- One of two students retained for academic year after end of seasonal summer work

Seasonal Student Worker, Greenscape Landscape and Lawn Care (2003-2004)

- Completed municipal and private lawn-care contracts without supervision
- Constructed retaining walls, one-hole golf course, Japanese rock garden, and other projects
- Operated heavy equipment including dump trucks, Gehl/Bobcat lifts, and front-end loader
RESEARCH

GRANTS AND CONTRACTS RECEIVED

Overhead Crane Installation and Enhancement of Distance Learning at Missouri S&T Reactor
PI: Dr. Ayodeji Alajo; co-PI: Dr. Joshua Schlegel, Dr. Hyoung-Koo Lee, Dr. Xin Liu, Dr. Shoaib Usman, Dr. Joseph Graham
Project Period: October 1, 2018 – September 30, 2019
Total Budget: $250,000

Undergraduate Scholarships in Nuclear Engineering at Missouri S&T (2018-2020)
PI: Prof. Hyoong-Koo Lee, co-PI: Prof. Joshua Schlegel
Period: August 1, 2018 – July 31, 2020
Total Budget: $200,000 (US NRC)

Radiation Response of Phase Change Materials for Space and Nuclear Applications
PI: Dr. Joshua Schlegel
Project Period: April 1, 2018 – June 30, 2018
Total Budget: $8,500 (MRC Seed Funding)

Undergraduate Scholarships in Nuclear Engineering at Missouri S&T (2017-2019)
PI: Prof. Hyoung-Koo Lee, co-PI: Prof. Joshua Schlegel
Period: August 1, 2017 – July 31, 2019
Total Budget: $200,000 (US NRC)

Development and Testing of the DCCP-4 and its Measurement Principle
PI: Dr. Mamoru Ishii, Purdue University (75%), co-PI: Dr. Joshua Schlegel, Missouri S&T
Period: March 1, 2017 – September 29, 2018
Total Budget: $8,000 (subcontract)

Contribution: Data analysis for performance comparison with existing measurement techniques and technical review of all publications.

Facility Integration for Synthesis and Testing of Nano-Radioisotopes at Missouri S&T
PI: Prof. Carlos H. Castaño Giraldo; co-PI: Dr. Xin Liu (30%), Dr. Joshua Schlegel (30%)
Period: --
Total Budget: $19,000 (Innovation at Missouri S&T)

Undergraduate Scholarships in Nuclear Engineering at Missouri S&T - III
PI: Prof. Hyoong-Koo Lee, co-PI: Prof. Joshua Schlegel (30%)
Period: August 1, 2016 – July 31, 2018
Total Budget: $200,000 (US NRC)

Contribution: Primarily responsible for preparing proposal and reports; serve on selection committee.

Development of Improved Drift-Flux Model for Rod Bundles at Moderate Pressures
PI: Prof. Joshua P. Schlegel
Period: November 15, 2015 – February 5, 2016
Total Budget: $30,000 (Institute of Nuclear Safety Systems, Inc.)

Undergraduate Scholarships in Nuclear Engineering at Missouri S&T - II
PI: Prof. Hyoong-Koo Lee, co-PI: Prof. Joshua Schlegel (30%)
Period: August 1, 2015 – July 31, 2017
Total Budget: $200,000 (US NRC)

Contribution: Primarily responsible for preparing proposal and reports; serve on selection committee.

Experimental Validation of Models and Simulations in Nuclear Systems
PI: Prof. Joshua P. Schlegel
Period: February 1, 2015 – January 31, 2018
Total Budget: $55,000 (University of Missouri Research Board)

Graduate Fellowships in Nuclear Engineering at Missouri S&T 2014-2021
PI: Prof. Hyoong-Koo Lee, co-PI: Prof. Joshua P. Schlegel
Period: August 1, 2014 – June 29, 2021
Total Budget: $400,000 (US NRC)

Undergraduate Scholarships in Nuclear Engineering at Missouri S&T
PI: Prof. Hyoong-Koo Lee, co-PI: Prof. Joshua Schlegel (40%)
Period: August 1, 2014 – July 31, 2016
Total Budget: $200,000 (US NRC)
Contribution: Primarily responsible for preparing proposal and reports; serve on selection committee.

Condensation Heat Transfer Experiment and Scaling
Co-PIs: Prof. Shoaib Usman (60%), Prof. Joshua P. Schlegel (40%)
Project Period: August 1, 2014 – June 30, 2015
Total Budget: $90,000 (SMR Research and Education Consortium)
Contribution: Primarily responsible for design and construction of test facility, performing experiments, and preparation of final report

Interfacial Area Transport Study in Gas-Dispersed Flow up to the Churn-Turbulent to Annular Flow Regime Transition
PI: Prof. Mamoru Ishii, Purdue University (75%); Prof. Joshua P. Schlegel, Missouri S&T (25%)
Project Period: August 1, 2014 – August 31, 2015
Total Budget: $619,000 (Bechtel Bettis Marine Propulsion)
Subcontract Budget: $33,000 (PI: Prof. Joshua P. Schlegel, Missouri S&T)
Contribution: Provide technical advice, primarily responsible for preparation of technical reports

Code Development for the Prediction of Bubble Coalescence and Breakup Rates in the Churn-Turbulent Flow Regime, Phase II
PI: Prof. Takashi Hibiki, Purdue University (25%); Co-PI: Prof. Joshua P. Schlegel, Missouri S&T (75%)
Project Period: April 1, 2014 – December 31, 2014
Total Budget: $120,000 (Chevron Energy Technology Company)
Subcontract Budget: $46,500 (PI: Prof. Joshua P. Schlegel, Missouri S&T)
Contribution: Performed all computational analysis and prepared final technical report

Additional Proposals Submitted

CAREER: Effect of Radiation Damage on Organic Phase Change Materials
PI: Dr. Joshua P. Schlegel
Project Period: January 1, 2019 – December 31, 2024
Total Budget: $593,665
Status: Not Funded

Interfacial Area Transport Model Optimization
PI: Dr. Joshua Schlegel
Project Period: January 1, 2018 – December 31, 2018
Total Budget: $80,000 (Bettis Atomic Power Laboratory)
Status: Not Funded
Contribution: Prepare Pareto optimization software and analyze empirical coefficients in key bubble coalescence and breakup models

CMMI: Enhancing energy efficiency in building systems through PCM-doped concrete
PI: Dr. Joshua P. Schlegel (50%); co-PI: Dr. Weina Meng, Dr. Kamal Khayat (50%)
Project Period: May 1, 2018 – April 30, 2019
Total Budget: $375,000
Status: Not Funded
Contribution: Preparation of phase change materials, evaluation of thermal properties, and overall management of project.

Advancing Two-Phase Simulation (RELAP-7) for Light Water Reactors by a Novel Integration of Advanced Measurement Techniques Implemented in a Represented Core Geometry
PI: Dr. Muthanna Al-Dahhan; Co-PI: Dr. Joshua Schlegel (20%), Dr. Marc-Oliver Delchini (ORNL), Neven Ali (UNM), Anca Hatman (AREVA), John Strumpell (AREVA)
Project Period: October 1, 2018 – September 30, 2021
Total Budget: $800,000 (Department of Energy)
Status: Not Funded
Contribution: Design liquid sodium recirculation loop to operate at 500°C; Oversee construction and operation of loop; Model bubble formation in liquid sodium; Manage regular reporting

Evaluating Suitability of Phase Change Materials for Passive Nuclear Reactor Safety
PI: Dr. Joshua Schlegel; co-PI: Dr. Muhammed Yousaf (Purdue University), Dr. Mamoru Ishii (Purdue University), Dr. Shanbin Shi (University of Michigan), Dr. Reyad Sawafta (Phase Change Energy Solutions)
Project Period: October 1, 2018 – September 30, 2021
Total Budget: $800,000 (Department of Energy); Missouri S&T: $180,000
Status: Not Funded
Contribution: Coordinate efforts across multiple partners; Scaling analysis and experimental design; Evaluation and analysis of data; Manage regular reporting

Development of Advanced 3-D Modeling Capability for RELAP-7
PI: Dr. Dean Wang (UMass-Lowell); co-PI: Dr. Joshua Schlegel, Dr. Robert Salko (ORNL), Dr. Ling Zou (INL), Dr. Wenfeng Liu (ANATECH Corp.)
Project Period: October 1, 2018 – September 30, 2021
Total Budget: $800,000 (Department of Energy); Missouri S&T: $180,000
Status: Not Funded
Contribution: Model evaluation, selection, and/or development for multiphase subchannel analysis and computational fluid dynamics

Thermal Fluids Laboratory for Nuclear Engineers
PI: Dr. Joshua P. Schlegel
Project Period: September 1, 2018 – August 31, 2019
Total Budget: $78,000 (Department of Energy)
Status: Not Funded

CAREER: Effect of Nanoparticle Alignment and Radiation Damage on Phase Change Material Performance
PI: Dr. Joshua Schlegel
Project Period: January 1, 2018 – December 31, 2023
Total Budget: $630,000 (Department of Energy)
Status: Not Funded

Evaluating Suitability of Phase Change Materials for Passive Nuclear Reactor Safety
PI: Dr. Joshua Schlegel; co-PI: Dr. Mamoru Ishii (Purdue University), Dr. Reyad Sawafta (Phase Change Energy Solutions)
Project Period: October 1, 2017 – September 30, 2020
Total Budget: $400,000 (Department of Energy)
Status: Not Funded

Transient Analysis of RCCS and Computational Tool Validation for Natural convection
PI: Dr. Shoaib Usman; co-PI: Dr. Joshua Schlegel; Dr. Mike Corradini, University of Wisconsin-Madison; Dr. Darius Lisowski, ANL; Dr. Vivek Agarwal, INL; F. Shahrrokhi, AREVA.
Project Period: October 1, 2016 – September 30, 2019
Total Budget: $800,000 (Department of Energy)
Status: Not Funded

Condensation Heat Transfer in Small Modular Reactor Containments
PI: Dr. Joshua Schlegel; co-PI: Dr. Shoaib Usman
Project Period: October 1, 2015 – September 30, 2018
Total Budget: $400,000 (Department of Energy)
Status: Not Funded

Bubble Plume Experiments for Validation of CFD Analyses
PI: Dr. Joshua Schlegel; co-PI: Dr. Takashi Hibiki, Purdue University; Dr. Joseph Smith, Missouri S&T
J.P. Schlegel

Project Period: October 1, 2015 – September 30, 2018
Total Budget: $800,000 (Department of Energy)
Status: Not Funded

NSTF Experiments for Reactor Cavity Cooling System CFD Validation
PI: Dr. Joshua Schlegel; co-PI: Dr. Takashi Hibiki, Purdue University; Dr. Vivek Agarwal, Idaho National Laboratory
Project Period: October 1, 2015 – September 30, 2018
Total Budget: $800,000 (Department of Energy)
Status: Not Funded

PUBLICATIONS  https://scholar.google.com/citations?user=mhpWWK8AAAAJ&hl=en

Ph.D. Thesis

M.S. Thesis

Books and Book Chapters

Papers in Progress
Swearingen, A., J.P. Schlegel, and T. Hibiki. Sensitivity of the two-fluid model to drift-flux constitutive relations
Swearingen, A., and J.P. Schlegel. Sensitivity of two-fluid model calculations to interfacial area concentration prediction methods.
Mills, C., and J.P. Schlegel. Improved signal processing and bubble classifications for four-sensor conductivity and optical void probes.
Bhowmik, P., V. Kalra, J.P. Schlegel, C. Mills, and S. Usman. Experimental measurement of condensation heat transfer rates in tubes of various diameter.
Saeed, R., J.P. Schlegel, et al. Design of PCM based heat exchangers for thermal management
Lin, Y., et al. Subcooled boiling modeling in CFD.

Under Review
Saeed, R., J.P. Schlegel, et al. Octadecanoic (Stearic) acid as a high-temperature phase change material. Under Review
Zhao, Y., et al. Departure diameter and frequency during subcooled boiling in a vertical annulus. Under Review


Peer-Reviewed Journals

<table>
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<tr>
<th>Citation</th>
<th>Impact Factor</th>
<th>Citations</th>
<th>Year</th>
</tr>
</thead>
</table>

1 Research Advisee or co-Advisee
2 CiteScore, Impact factor not available for this journal


Invited Presentations


Conference Proceedings (Peer-Reviewed)


TEACHING

GRADUATE STUDENT SUPERVISION

Ph.D. Degrees Completed:

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<th>Date</th>
<th>Student</th>
<th>Thesis/Dissertation Title</th>
<th>Current Position</th>
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<tbody>
<tr>
<td>August</td>
<td>Chandler Mills</td>
<td>Measurement of Interfacial Area Concentration</td>
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<td>May</td>
<td>Rami Saeed</td>
<td>Advances in Phase Change Materials for Thermal Energy Storage</td>
<td>Senior Energy Scientist</td>
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<td>Phase Change Energy Solutions, Inc.</td>
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M.S. Degrees Completed:

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<th>Thesis/Dissertation Title</th>
<th>Current Position</th>
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<tbody>
<tr>
<td>May</td>
<td>Rami Saeed</td>
<td>Thermal Characterization of Phase Change Materials for Thermal Energy Storage</td>
<td>Senior Energy Scientist</td>
</tr>
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<td>Phase Change Energy Solutions, Inc.</td>
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<tr>
<td>May</td>
<td>Varun Kalra</td>
<td>CFD Validation and Scaling of Condensation Heat Transfer</td>
<td>Research Scientist</td>
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<tr>
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<td></td>
<td>Phase Change Energy Solutions, Inc.</td>
</tr>
<tr>
<td>May</td>
<td>Raymond Fanning</td>
<td>W-SMR Passive Safety Natural Convection Heat Exchanger</td>
<td>Idaho National Laboratory</td>
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Degrees in Progress

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<tr>
<th>Degree</th>
<th>Student</th>
<th>Thesis/Dissertation Topic</th>
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<tbody>
<tr>
<td>Ph.D.</td>
<td>Hiralkumar Patel 4</td>
<td>Droplet Impingement on Heated Wall in Post-CHF Flow Boiling</td>
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<tr>
<td>Ph.D.</td>
<td>Hayder Alnaseri 4,5</td>
<td>Bubble Dynamic Properties in Low Height Bubble and Slurry</td>
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<td>Bubble Column with Internals for Fischer-Tropsch Synthesis</td>
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<tr>
<td>Ph.D.</td>
<td>Palash Bhowmik</td>
<td>Condensation Heat Transfer Rates in Passive Safety Systems</td>
</tr>
<tr>
<td>Ph.D.</td>
<td>Abbas Jawad 4,5</td>
<td>Radiation Effects on Phase Change Material Performance</td>
</tr>
<tr>
<td>Ph.D.</td>
<td>Ryan Steere</td>
<td></td>
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<tr>
<td>Ph.D.</td>
<td>Song Je Hong</td>
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<tr>
<td>Ph.D.</td>
<td>Alexander Swearingen</td>
<td>Evaluating the Sensitivity of Numerical Two-Fluid Model Predictions</td>
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4 Co-Advisee
### Advisory Committee Service

<table>
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<tr>
<th>Degree</th>
<th>Date</th>
<th>Student</th>
<th>Thesis/Dissertation Topic</th>
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<tbody>
<tr>
<td>Ph.D.</td>
<td>December 2015</td>
<td>Muhammad Yousaf</td>
<td>Study of Heat Transfer Phenomenon During Natural Convection</td>
</tr>
<tr>
<td>M.S.</td>
<td>May 2016</td>
<td>Maria Camila Garcia Toro</td>
<td>Production of Activated Gold Nanoparticles by Radiolysis</td>
</tr>
<tr>
<td>M.S.</td>
<td>May 2016</td>
<td>Jonathan Schattke</td>
<td>Accelerator-Driven Liquid-Metal Cooled Reactor System</td>
</tr>
<tr>
<td>M.S.</td>
<td>December 2016</td>
<td>Benjamin Prewitt</td>
<td>Analysis and Implementation of Accident Tolerant Fuels</td>
</tr>
<tr>
<td>Ph.D.</td>
<td>August 2017</td>
<td>Fahima Islam</td>
<td>Studies on Neutron Diffraction and X-Ray Radiography for Material Inspection</td>
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<tr>
<td>M.S.</td>
<td></td>
<td>Brandon Bringer</td>
<td>Hydrodynamic Investigation and Performance Evaluation of Upflow Packed or Expanded Bed Hydrotreater Reactor with Conical Bottom Using Advanced Measurement and Computing Technique</td>
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<tr>
<td>Ph.D.</td>
<td>May 2018</td>
<td>Vineet Alexander(^5)</td>
<td>Out-Core 3D Fission Density Monitoring for SMRs</td>
</tr>
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<td>Ph.D.</td>
<td>May 2018</td>
<td>Athanas Mutiso</td>
<td>Hydrodynamic Investigation and Performance Evaluation of Upflow Packed or Expanded Bed Hydrotreater Reactor with Conical Bottom Using Advanced Measurement and Computing Technique</td>
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<td>Ph.D.</td>
<td>December 2016</td>
<td>Vivek Rao(^5)</td>
<td>Numerical Investigation of Transient Thermal-Hydraulic Instabilities in a Small Modular Reactor</td>
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<td>Ph.D.</td>
<td>December 2017</td>
<td>Qingzi Zhu(^6)</td>
<td>Droplet-Capable Conductivity Probe for Two-Phase Flow Measurements</td>
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<td>Ph.D.</td>
<td>December 2017</td>
<td>Mahmoud Moharan(^5)</td>
<td>Experimental Investigation of Natural Circulation in Separate and Mixed Effects Test Facility Mimicking Prismatic Modular Reactor Core</td>
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<td>Ph.D.</td>
<td>May 2018</td>
<td>Thaar Aljuwaya</td>
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<tr>
<td>M.S.</td>
<td>December 2018</td>
<td>Jessica Seals</td>
<td>Non-Thesis</td>
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### COURSES DEVELOPED AND TAUGHT

#### Undergraduate Courses

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<thead>
<tr>
<th>Year Developed</th>
<th>Course Number and Title</th>
<th>Taught</th>
<th>Overall Effectiveness (4.0 scale)(^7)</th>
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<tbody>
<tr>
<td>2018</td>
<td>NE 2001: Professional Development for Nuc Eng</td>
<td>Fall 2018</td>
<td>3.75</td>
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<tr>
<td></td>
<td>NE 2105: Introduction to Nuclear Engineering</td>
<td>Spring 2014</td>
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<tr>
<td></td>
<td>NE 3221: Reactor Fluid Mechanics</td>
<td>Fall 2015 - Present</td>
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<td>NE 3223: Reactor Heat Transfer</td>
<td>Spring 2016 - Present</td>
<td>2.82</td>
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<td>2015</td>
<td>NE 4257: Two-Phase flow in Energy Systems</td>
<td>Spring 2015 - Present</td>
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<td>NE 4496: Nuclear Systems Design I</td>
<td>Fall 2015-Present</td>
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<td>NE 4497: Nuclear Systems Design II</td>
<td>Spring 2016-Present</td>
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#### Graduate Courses

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<th>Year Developed</th>
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<th>Taught</th>
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<tr>
<td>2015</td>
<td>NE 5257: Introduction to Nuclear Thermal-Hydraulics</td>
<td>Fall 2015 - Present</td>
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<tr>
<td></td>
<td>NE 6099: Advanced Topics in Nucl T-H</td>
<td>Fall 2014 - Present</td>
<td>--</td>
</tr>
<tr>
<td>2016</td>
<td>NE 6257: Advanced Nuclear Thermal-Hydraulics</td>
<td>Fall 2014 - Present</td>
<td>3.60</td>
</tr>
</tbody>
</table>

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\(^5\) Student in Chemical Engineering  
\(^6\) Student at Purdue University  
\(^7\) Most recent evaluation only
SERVICE

PROFESSIONAL SOCIETIES
American Nuclear Society, 2005–Present
    Thermal Hydraulics Division, Young Members Group, 2014 – Present
Purdue University Student Chapter, 2005-2012
    Outreach Committee Member, 2009-2011
    Graduate Representative, 2009-2011
Atomic Energy Society of Japan, 2015 – Present
    Thermal Hydraulics Division

AWARDS AND HONORS
Young Member Achievement Award, Thermal Hydraulics Division, Atomic Energy Society of Japan, 2017
Purdue University Outstanding Service Award, College of Engineering, Purdue University, 2011
US NRC Graduate Fellowship, 2010-2011
INPO Graduate Fellowship, 2007-2008
Alpha Nu Sigma (Nuclear Engineering Honor Society), 2007-Present
    Secretary (Purdue University), 2008-2009
Eagle Scout, Boy Scouts of America, 2001

PROFESSIONAL SERVICE

International Service
Reviewer
    Fluids – 5/17/16;
    International Journal of Multiphase Flow- 3/15/16; 1/16/19;
    Chemical Engineering Science – 11/6/15; 1/13/16;
    Annals of Nuclear Energy – 10/1/13; 12/10/13; 7/17/14; 8/12/14; 10/31/16;
    Nuclear Engineering and Design – 7/6/15; 11/22/15; 01/29/2018; 03/14/2018; 08/24/2018; 12/19/2018;
    International Journal of Heat and Mass Transfer – 04/07/16; 07/18/16; 09/21/2016; 03/07/17; 07/13/2017;
        09/06/2017; 10/17/2017; 09/07/2018;
    Nuclear Science and Engineering – 2/24/16;
    Sensors – 4/29/16; 8/1/16; 10/4/16; 03/22/2018
    Applied Thermal Engineering – 8/29/16;
    International Journal of Heat and Fluid Flow – 07/13/2017; 09/06/2017; 03/21/18
    Journal of Nuclear Science and Technology – 08/10/2017;
    The Open Chemical Engineering Journal – 08/10/2017;
    Progress in Nuclear Energy – 10/13/2017;
    Nuclear Energy and Technology – 11/13/2017;
    Experimental Thermal and Fluid Science – 12/20/2017; 01/09/2018;
26th International Conference on Nuclear Engineering (ICONE 26)
    July 22-26, 2018
        Reviewer, 3 papers
17th International Topical Meeting on Nuclear Reactor Thermal Hydraulics (NURETH-17)
    September 3 – 8, 2017
        Reviewer
25th International Conference on Nuclear Engineering (ICONE 25)
    May 14-18, 2017
        Reviewer
11th International Topical Meeting on Nuclear Thermal Hydraulics, Operation and Safety (NUTHOS-11),
    October 9-13, 2016
        Reviewer
2016 International Congress on Advances in Nuclear Power Plants (ICAPP-16)
    April 17-20, 2016
Reviewer
16th International Topical Meeting on Nuclear Reactor Thermal Hydraulics (NURETH-16)
August 30 – September 4, 2015
Reviewer: Session Chair

Missouri S&T
Nuclear Science Design Team Co-Advisor, 2015 – Present
MITE Summer Camp – Introduction to Nuclear Engineering Presentation, 2015 – Present
Reconnection 2 Panelist – Tips for Student Success, 2017

Department of Mining and Nuclear Engineering
Undergraduate Coordinator, 2017 – Present
Nuclear Engineering Facebook Page Administrator, 2015 – Present
Nuclear Engineering NRC Scholarship Committee, 2014 – Present
Nuclear Engineering Program Curriculum Committee, 2015 – Present
Chair: 8/2016 – Present
Mining and Nuclear Engineering Chair Search Committee, 2015-2016

Purdue University
Nuclear Engineering Ambassadors, 2009-2012
School of Nuclear Engineering, Purdue University
College of Engineering/Graduate School Recruiter, 2010-2011
College of Engineering, Purdue University

COMMUNITY SERVICE
Christian Life Church, Rolla, MO, 2017 – Present
Lighting Designer and Technician
Lafayette Civic Theater; Lafayette, IN, 2012-2014
Lighting Designer and Master Electrician
HorrorHound Weekend; Indianapolis, IN, 2010-2014
Volunteer Coordinator
Hilltop Hall Council
Senator, 2003-2005
Vice President, 2005-2006
Service Learning, School of Foreign Languages, Purdue University, 2004
Student Union Board, Recreation Committee, 2003-2004
Sheboygan Theater Company; Sheboygan, WI, 2001-2004
Master Electrician

PROFESSIONAL DEVELOPMENT
Troubleshooting Teams – October 23, 2017; 1.5 Contact Hours
Advising Conference Series: MyDegree – October 16, 2017; 1 Contact Hour
Curator’s Teaching Summit: Graduate and Undergraduate Teaching – September 22, 2017; 1 Contact Hour
Preparing for Next Semester: Accelerate Learning and Reduce Grading Time - April 24, 2017; 1 Contact Hour
Developing Versatile Active Learning Strategies - April 6, 2017; 1 Contact Hour
How is Your Course Structured? - April 4, 2017; 1.5 Contact Hours
Team Alchemy: Evaluating Team Effectiveness - February 24, 2017; 1 Contact Hour
Building Functional Teams in the Classroom - January 12, 2017; 5 Contact Hours
Walk Through Promotion and Tenure - November 21, 2016; 4.5 Contact Hours
Scholarship of Teaching and Learning - November 7, 2016; 1.5 Contact Hours
Curator’s Teaching Summit: Practical Tips for Student Success - October 13, 2016; 1.5 Contact Hours
University of Missouri Faculty Scholars Program - AY 2015-2016
Assessing Active Learning - April 8, 2016; 1 Contact Hour
Recruiting and Hiring a Diverse Workforce - March 16, 2016; 1.5 Contact Hours
Academic Advising Series: Advising 101 - March 7, 2016; 1 Contact Hour
Academic Advising Series: Experiential Learning - February 15, 2016; 1 Contact Hour
Building Blocks: Structuring Your Course for Success - *January 15, 2016; 5 Contact Hours*

Academic Advising Series: Financial Aid 101 - *November 16, 2015; 1.5 Contact Hours*

Freshman Faculty Forum - *AY 2014-2015*

Curator’s Teaching Summit, “Great Expectations: Bridging the Gap Between Instructor and Student Expectations” - *September -December 2014; 4.5 Contact Hours*

Getting Students to Focus on Learning instead of Grades - *February 11, 2015; 1.5 Contact Hours*
APPENDIX B – INFORMATION REQUESTS

Subject: Drift-flux question
From: Helge Gonnermann <helge@rice.edu>
Date: 9/15/2014 6:34 AM
To: <schlegelj@mst.edu>

Dear Dr. Schlegel,

I am working on the modeling of volcanic eruptions and am wondering to what extent you would recommend the use of drift flux theory in 1-dimensional models of magma ascent (H2O and CO2 vapor bubbles of 0.01 mPa.s viscosity in silicate melt of 10 Pa.s).

I am dealing with superficial gas velocities ranging between 0.1 to >10 m/s at superficial liquid velocities of 1 to >10 m/s, within the upper-most 500 m in volcanic conduits of about 10 m radius/diameter (presumably near cylindrical).

I have been struggling to ascertain whether there is sufficient experimental or theoretical basis, due to high viscosity and/or large conduit diameter, to justify applying drift flux theory to modeling flow in the upper 500 m in volcanic conduits.

Thank you very much for your help,
Helge Gonnermann

Assistant Professor
Department of Earth Science
Rice University

Subject: Request of paper copy
From: "Tikhonov, Vadim" <Vadim.Tikhonov@eu.weatherford.com>
Date: 4/4/2016 4:46 AM
To: "schlegelj@mst.edu" <schlegelj@mst.edu>

Dear Professor Joshua Paul Schlegel,

I, together with colleagues from Novosibirsk, am developing a models of the liquid-gas two-phase flow in vertical oil wells. I am very interested in your works on the development of drift-flux models for pipes of large diameter.

I'll be grateful to you if you send me a copy of your paper:

Schlegel P.J., Hibiki T., Ishii M., 2010, Progress in Nuclear Energy, 52...

Thanks a lot.

Yours sincerely,

Vadim Tikhonov
Subject: Reviewer Invitation for NED-D-15-00779
From: Nuclear Engineering and Design <ned@elsevier.com>
Date: 11/6/2015 5:59 AM
To: "Schlegel, Joshua P" <schlegel@mst.edu>

Ms. Ref. No.: NED-D-15-00779
Title: A Solver for the Two-Phase Two-Fluid Model Based on High-Resolution Total Variation Diminishing Scheme
Nuclear Engineering and Design

Dear Dr. Schlegel:

This paper presents a numerical scheme to solve the two phase two fluid thermal hydraulics equations with comparison with TRACE code and with claimed better accuracy. Given you are recognized as a world leading expert in this technical area, I would appreciate your review comments on this manuscript. I have included the abstract of the manuscript below to provide you with an overview.

I recognize you have performed excellent reviews for us recently. This could be an extra burden to you to review another manuscript for us within such a short time frame. However, your expertise is hard to come by and the quality of your previous review is highly recognized and appreciated. I have no choice but to invite you again so soon.

If you accept this invitation please let me know your acceptance in 12 days or sooner (not for finishing the review.) Yet, the actual due date for your review comments could be extended to 24 days. If you need more time to finish the review please let me know. Either way, I appreciate a response from you in time.

If you are unable to act as a reviewer at this time, I would greatly appreciate your suggestions for alternative reviewers.

Yours sincerely,

Jason Chao, Ph. D.
Editor
Nuclear Engineering and Design
APPENDIX C – SELECTED CITATIONS OF MY WORK


May 26-28, Kota Kinabalu, Borneo, Malaysia.
APPENDIX D – COURSE SYLLABI

NUC ENG 2001: Professional Development for Nuclear Engineers

PROFESSIONAL DEVELOPMENT FOR NUCLEAR ENGINEERS
NUC ENG 2001

INSTRUCTOR:
Dr. Joshua P. Schlegel
226 Fulton Hall
Email: schlegelj@mst.edu

TEXT BOOK:
None

COURSE DESCRIPTION:
An outline of key topics in professional development important for the success of engineering students both during their education and in their profession. Content will range from resume development to technical writing, problem solving approaches, and using computers to solve various types of engineering problems.

COURSE OBJECTIVES:
1. Develop an understanding of the role of professional development in engineering careers
2. Understand and use learning styles to your advantage
3. Read, understand, and write scientific material
4. Use computers to solve simple engineering problems

What will students get out of this class?
- Improved critical thinking abilities
- Ability to understand and take advantage of professional development opportunities
- Improved ability to set up engineering problems and communicate scientific information

GRADING POLICY:
The course will be graded on a pass/fail basis. The result will be based on participation and submission of all assignments required during the course.

HOMEWORK:
Occasional homework assignments will be posted in Canvas. Grades will be based on completion.

CANVAS:
Lecture presentations, homework assignments, and supplemental material will be posted on Canvas in a timely fashion. Please note that the lectures do not contain all of the necessary information, so these files are not a substitute for attending lectures. Follow your progress on Canvas, and speak to the instructor if you are concerned about your progress.

ATTENDANCE AND PARTICIPATION:
Participation in class, and therefore attendance, is important to developing the skills necessary to succeed in any course. Not all of the important material will be included in the presentation slides; a good deal will be presented and discussed only in class. That said, attendance will not be taken in this class. You are responsible for your own attendance. If you must miss class for some reason (other coursework, family emergency, sick, etc) please inform the instructor prior to, or as soon as possible after, the missed class to make arrangements related to missed material.
It is expected that you will be respectful during class periods. Please keep outside distractions to a minimum. Do not engage in side conversations with other students. Electronics in the classroom are encouraged, but don’t let them become a distraction. Keep cell phones and tablets on silent.

**ACADEMIC DISHONESTY:**
A student enrolling in the University assumes an obligation to behave in a manner compatible with the University's function as an educational institution. Page 33 of the Student Academic Regulations handbook describes the student standard of conduct relative to the System's Collected Rules and Regulations section 200.010, and offers descriptions of academic dishonesty including cheating, plagiarism or sabotage (http://registrar.mst.edu/media/administrative/registrar/documents/academicregulations/academic regulations 2014-2016.pdf). Please review the Student Academic Regulations in the address above. Plagiarism, cheating, and other forms of academic dishonesty will result in a failing grade for the assignment and possibly the course.

The student council honor code can be found at http://stuco.mst.edu/about/honor.shtml. The honor code highlights two important topics: honesty and respect.

**DISABILITY SUPPORT SERVICES:**
Any student inquiring about academic accommodations because of a disability should contact Disability Support Services so that appropriate and reasonable accommodative services can be determined and recommended. Disability Support Services is located in 204 Norwood Hall. Their phone number is 341-4211 and their email is dss@mst.edu.

http://dss.mst.edu

**CONCERNS AND COMPLAINTS:**
If there are concerns of complaints please talk to me and I will try to respond your worries and concerns. If you feel you cannot talk with me, please feel free to talk to the Program Chair, Dr. Hyoung K. Lee (leehk@mst.edu).

**TITLE IX:**
Missouri University of Science and Technology is committed to the safety and well-being of all members of its community. US Federal Law Title IX states that no member of the university community shall, on the basis of sex, be excluded from participation in, or be denied benefits of, or be subjected to discrimination under any education program or activity. Furthermore, in accordance with Title IX guidelines from the US Office of Civil Rights, Missouri S&T requires that all faculty and staff members report, to the Missouri S&T Title IX Coordinator, any notice of sexual harassment, abuse, and/or violence (including personal relational abuse, relational/domestic violence, and stalking) disclosed through communication including but not limited to direct conversation, email, social media, classroom papers and homework exercises.

Missouri S&T’s Title IX Coordinator is Vice Chancellor Shenethia Manuel. Contact her directly (manuels@mst.edu; (573) 341-4920; 113 Centennial Hall) to report Title IX violations. To learn more about Title IX resources and reporting options (confidential and non-confidential) available to Missouri S&T students, staff, and faculty, please visit http://titleix.mst.edu.
**TENTATIVE SCHEDULE (subject to change):**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Course Introduction; Professional Societies</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Preparing Your Resume</td>
<td>Upload your resume on Canvas</td>
</tr>
<tr>
<td>3</td>
<td>Writing a Cover Letter</td>
<td>Upload your cover letter on Canvas</td>
</tr>
<tr>
<td>4</td>
<td>Finding a Position</td>
<td>Upload one interesting job opening on Canvas</td>
</tr>
<tr>
<td>5</td>
<td>Job Interviews</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Reading and Analyzing Scientific Literature</td>
<td>Upload annotated textbook chapter to Canvas</td>
</tr>
<tr>
<td>7</td>
<td>Writing Reports and Papers</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Preparing and Giving Presentations</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Using Your Learning Style</td>
<td>Upload a learning plan for one of your courses to Canvas</td>
</tr>
<tr>
<td>10</td>
<td>Engineering Approach to Problem Solving</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Engineering Approach to Problem Solving</td>
<td>Upload HW 6 Solutions to Canvas</td>
</tr>
<tr>
<td>12</td>
<td>Using MATLAB for Nuclear Engineering</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Using MATLAB for Nuclear Engineering</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Using EXCEL for Nuclear Engineering</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Using EXCEL for Nuclear Engineering</td>
<td>Upload HW 7 Solutions to Canvas</td>
</tr>
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</table>
NUC ENG 3221: Reactor Fluid Mechanics

REACTOR FLUID MECHANICS
NUC ENG 3221
MWF 11:00-11:50
Engineering Management 201

INSTRUCTOR:
Dr. Joshua P. Schlegel
226 Fulton Hall
Tel: 573.341.7703
Email: schlegelj@mst.edu

TEXT BOOK:

COURSE DESCRIPTION:
Learn to understand fluid mechanics problem statements involving incompressible viscous or inviscid flows. Translate those problems into a mathematical system: identify the appropriate control volume and control surface, then apply the balance equations, rate equations, simplifying assumptions, and boundary conditions. Solve the mathematical system, clearly communicate your results and be able to understand and discuss their significance. Topics include dimensional analysis, fluid statics, boundary layer theory, and applications to tube bundles. Focus on nuclear energy applications and nuclear reactors, including basic numerical methods.

COURSE OBJECTIVES:
1. Translate a problem statement into a mathematical model and solve the problem
2. Identify and apply key fluid mechanics concepts
3. Solve your mathematical model
4. Clearly communicate your work and its significance
5. Develop confidence in the use of key skills in fluid mechanics and apply them to nuclear reactor systems
6. Become productive members of a team

What will students get out of this class?
- Improved critical thinking abilities
- Ability to translate real-world problems into engineering models
- Ability to solve various kinds of fluid mechanics problems (even those they haven’t seen before)
- Better ‘engineering judgement’ regarding real-world applications (especially nuclear reactor behavior/analysis)
- Excitement about engineering problems
- Improved ability to work on project teams

GRADING POLICY:
Final grades will be assigned as detailed in Table 1. An ‘A’ grade reflects success on work that should challenge the top third of the class. A ‘B’ grade reflects success on work that should challenge the middle third of the class. A ‘C’ grade reflects success on work that should challenge the bottom third of the class. The instructor reserves the right to curve the grade distribution to reflect class performance and variations in the difficulty of exams and assignments.

Final grades will be divided into categories, as detailed in Table 2. The students will determine the weights associated with each of the categories during the first week of the semester. After the weights have been determined, the syllabus will be updated on Canvas. This grading system is designed to reward both individual effort and group effort.
Table 1: Final Grade Assignments

<table>
<thead>
<tr>
<th>Performance in the Class</th>
<th>Estimated Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent Performance in the Class</td>
<td>A  85-100</td>
</tr>
<tr>
<td>Good Performance in the Class</td>
<td>B  75-85</td>
</tr>
<tr>
<td>Acceptable Performance in the Class</td>
<td>C  65-75</td>
</tr>
<tr>
<td>Poor Performance in the Class</td>
<td>D  55-65</td>
</tr>
<tr>
<td>Failed to Meet the Minimum Class Requirement</td>
<td>F  0-55</td>
</tr>
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</table>

Table 2: Grade Categories

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Category</th>
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<tbody>
<tr>
<td>Individual Work</td>
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<tr>
<td>Individual RATs (6)</td>
<td></td>
</tr>
<tr>
<td>Homework Assignments (12)</td>
<td></td>
</tr>
<tr>
<td>Individual Exams (6)</td>
<td></td>
</tr>
<tr>
<td>Team Work</td>
<td></td>
</tr>
<tr>
<td>Team RATs (6)</td>
<td></td>
</tr>
<tr>
<td>Team problem sets (done in class)</td>
<td></td>
</tr>
<tr>
<td>Team Exams (6)</td>
<td></td>
</tr>
</tbody>
</table>

HOMEWORK AND EXAMS:
- Homework will be due one week from the date it is assigned
  - Late homework will not be accepted
  - One homework to be submitted per person – **SUBMIT YOUR OWN WORK**
- Homework grading
  - **20 points will be awarded for formatting.** As engineers, communicating our work is essential or it doesn’t do anyone any good.
  - **Write legibly** and large enough to read clearly. **Work neatly.** Clearly show your work.
    - Illegible handwriting or sloppy work WILL result in lost points!
  - Include your name, class number, and assignment in the header of each page. Also include the page number for assignments with multiple pages.
  - **Use engineering paper or white paper.** Use a separate sheet for each problem. Staple multiple pages. The instructor is not responsible for missing pages.
  - Be mindful of significant digits.
  - Always double-check your **units** and conversions.
  - Make sure to read the problem carefully, and answer the question correctly.
- Exams will be given in class
  - An equation sheet will be provided for each exam.
  - Bring a calculator for the exams.

CANVAS:
Presentations, homework assignments, supplemental material, etc. will be posted on Canvas in a timely fashion. All pertinent course information will be posted including announcements, course discussion boards, etc.

**ATTENDANCE AND PARTICIPATION:**
Participation in class, and therefore attendance, is important to developing the skills necessary to succeed in any course. Not all of the important material will be included in the presentation slides; a good deal will be presented and discussed only in class. That said, attendance will not be taken in this class. You are responsible for your own attendance. If you must miss class for some reason (other coursework, family emergency, sick, etc) please inform the instructor prior to, or as soon as possible after, the missed class to make arrangements related to missed material.

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### COURSE SCHEDULE:

<table>
<thead>
<tr>
<th>Module</th>
<th>Week</th>
<th>In-Class</th>
<th>Out of Class</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module 1: Control Volume Analysis</strong></td>
<td>1</td>
<td>Readiness Assessment Test; Lecture</td>
<td>1.1-1.6; 2.1-2.2; 3.4; 5.5; 6.1-6.3;</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>In-Class Concept Problems</td>
<td>Homework 1</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>In-Class Application Problems</td>
<td>Homework 2; Exam 1</td>
</tr>
<tr>
<td><strong>Module 2: Differential Analysis</strong></td>
<td>4</td>
<td>Readiness Assessment Test; Lecture</td>
<td>1.7-1.8; 7.1-7.5; 7.11-7.12; 8; 9.1-9.4</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>In-Class Concept Problems</td>
<td>Homework 3</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>In-Class Application Problems</td>
<td>Homework 4; Exam 2</td>
</tr>
<tr>
<td><strong>Module 3: Inviscid Flows</strong></td>
<td>7</td>
<td>Readiness Assessment Test; Lecture</td>
<td>2.3-2.10; 5.1-5.4; 7.6-7.10;</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>In-Class Concept Problems</td>
<td>Homework 5</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>In-Class Application Problems</td>
<td>Homework 6; Exam 3</td>
</tr>
<tr>
<td><strong>Module 4: Hydrodynamics</strong></td>
<td>10</td>
<td>Readiness Assessment Test; Lecture</td>
<td>9.5-9.8; 10.1-10.4; 11.1-11.10</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>In-Class Concept Problems</td>
<td>Homework 7</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>In-Class Application Problems</td>
<td>Homework 8; Exam 4</td>
</tr>
<tr>
<td><strong>Module 5: Fluid Machinery</strong></td>
<td>13</td>
<td>Readiness Assessment Test; Lecture</td>
<td>10.5; 14.1-14.8</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>In-Class Concept Problems</td>
<td>Homework 9</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>In-Class Application Problems</td>
<td>Homework 10</td>
</tr>
</tbody>
</table>
NUC ENG 3223: Reactor Heat Transfer

REACTOR HEAT TRANSFER
NUC ENG 3223

INSTRUCTOR:
Dr. Joshua P. Schlegel
226 Fulton Hall
Tel: 573.341.7703
Email: schlegelj@mst.edu

TEXTBOOK:

This course is part of our AutoAccess program designed to reduce the cost of course materials for students. You will be able to access the digital content for this course through Canvas on the first day of class automatically. It can be accessed through the “Modules” section of the course page.

Title: Principles of Heat Transfer
Edition 8
Content Type: ebook
AutoAccess price: $61.31

Students will be sent a welcome email with AutoAccess details on or about January 12, 2018. As always, students can reach out to autoaccess@mst.edu with question. Student accounts will be charged in early January for their AutoAccess content, but will have until January 30 to opt out. Students that opt out or drop the course by January 30 will be refunded accordingly.

COURSE DESCRIPTION:
Learn to understand heat transfer problem statements involving conduction, convection and thermal radiation. Translate those problems into a mathematical system: identify the appropriate control volume and heat transfer processes. Apply the balance equations, rate equations, simplifying assumptions, and boundary conditions. Solve the mathematical system. Clearly communicate your results and be able to understand and discuss their significance. Focus on nuclear energy applications and nuclear reactors, including basic numerical methods and CFD applications.

COURSE OBJECTIVES:
1. Translate a problem statement into a mathematical model and solve the problem
2. Identify and apply key heat transfer processes
3. Solve your mathematical model
4. Clearly communicate your work and understand its significance
5. Apply these principles to nuclear reactor systems
6. Learn to work effectively on project teams

What will students get out of this class?
- Improved critical thinking abilities
- Ability to translate real-world problems into engineering models
- Ability to solve various kinds of heat transfer problems (even those they haven’t seen before)
- Better ‘engineering judgement’ regarding real-world applications (especially nuclear reactor behavior/analysis)
- Excitement about engineering problems
- Improved ability to work on project teams
GRADING POLICY:
Final grades will be assigned as detailed in Table 1. An ‘A’ grade reflects success on work that should challenge the top third of the class. A ‘B’ grade reflects success on work that should challenge the middle third of the class. A ‘C’ grade reflects success on work that should challenge the bottom third of the class. The instructor reserves the right to curve the grade distribution to reflect class performance and variations in the difficulty of exams and assignments.

Final grades will be divided into categories, as detailed in Table 2. The students will determine the weights associated with each of the categories during the first week of the semester. After the weights have been determined, the syllabus will be updated on Canvas. This grading system is designed to reward both individual effort and group effort.

Table 1: Final Grade Assignments

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Category</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent Performance in the Class</td>
<td>A</td>
<td>85-100</td>
</tr>
<tr>
<td>Good Performance in the Class</td>
<td>B</td>
<td>75-85</td>
</tr>
<tr>
<td>Acceptable Performance in the Class</td>
<td>C</td>
<td>65-75</td>
</tr>
<tr>
<td>Poor Performance in the Class</td>
<td>D</td>
<td>55-65</td>
</tr>
<tr>
<td>Failed to Meet the Minimum Class Requirement</td>
<td>F</td>
<td>0-55</td>
</tr>
</tbody>
</table>

Table 2: Grade Categories

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Category</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual RATs (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homework Assignments (12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual Exams (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team Work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team RATs (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team problem sets (done in class)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team Exams (6)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HOMEWORK AND EXAMS:
- Homework will be due one week from the date it is assigned
  - Late homework will not be accepted
  - One homework to be submitted per person – **SUBMIT YOUR OWN WORK**
- Homework grading
  - **20 points will be awarded for formatting.** As engineers, communicating our work is essential or it doesn’t do anyone any good.
  - **Write legibly** and large enough to read clearly. **Work neatly.** Clearly show your work.
  - Illegible handwriting or sloppy work WILL result in lost points!
  - Include your name, class number, and assignment in the header of each page. **Also include the page number for assignments with multiple pages.**
  - **Use engineering paper or white paper.** Use a separate sheet for each problem. Staple multiple pages. The instructor is not responsible for missing pages.
  - Be mindful of significant digits.
  - Always double-check your **units** and conversions.
Make sure to read the problem carefully, and answer the question correctly.

Exams will be given in class

- An equation sheet will be provided for each exam.
- Bring a calculator for the exams.

**CANVAS:**
Presentations, homework assignments, supplemental material, etc. will be posted on Canvas in a timely fashion. All pertinent course information will be posted including announcements, course discussion boards, etc.

**ATTENDANCE AND PARTICIPATION:**
Participation in class, and therefore attendance, is important to developing the skills necessary to succeed in any course. That said, attendance will not be taken in this class.

In the workplace, when someone is absent, the group has to pick up the slack but the absent member benefits from the group work. If the absent person has a good reason for being gone, explains that reason to the group, and does their best to make amends, most groups will be happy to extend that benefit. However if group members have doubts about the reason for the absence, feel like the team member is trying to freeload, or both, then the absence is not likely to be forgotten when it is time for peer evaluations. If you must be absent let your team and the instructor know in advance and make sure that you do your best to make up for it.

It is expected that you will be respectful during class periods. Please keep outside distractions to a minimum. Do not engage in side conversations with other students. Electronics in the classroom are encouraged, but don’t let them become a distraction. Keep cell phones and tablets on silent.

**ACADEMIC DISHONESTY:**
A student enrolling in the University assumes an obligation to behave in a manner compatible with the University's function as an educational institution. Page 33 of the Student Academic Regulations handbook describes the student standard of conduct relative to the System's Collected Rules and Regulations section 200.010, and offers descriptions of academic dishonesty including cheating, plagiarism or sabotage (http://registrar.mst.edu/media/administrative/registrar/documents/academicregulations/academic_regulations_2014-2016.pdf). Please review the Student Academic Regulations in the address above. Plagiarism, cheating, and other forms of academic dishonesty will result in a failing grade for the assignment and possibly the course.

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Any student inquiring about academic accommodations because of a disability should contact Disability Support Services so that appropriate and reasonable accommodative services can be determined and recommended. Disability Support Services is located in 204 Norwood Hall. Their phone number is 341-4211 and their email is dss@mst.edu.

http://dss.mst.edu

**CONCERNS AND COMPLAINTS:**
If there are concerns of complaints please talk to me and I will try to respond your worries and concerns. If you feel you cannot talk with me, please feel free to talk to the Department Chair, Dr. Hyoung K. Lee (leehk@mst.edu).

**TITLE IX:**
Missouri University of Science and Technology is committed to the safety and well-being of all members of its community. US Federal Law Title IX states that no member of the university community shall, on the basis of sex, be excluded from participation in, or be denied benefits of, or be subjected to discrimination under any education program or activity. Furthermore, in accordance with Title IX guidelines from the US Office of Civil Rights, Missouri S&T requires that all faculty and staff members report, to the Missouri S&T Title IX Coordinator, any notice of sexual harassment, abuse, and/or violence (including personal relational abuse, relational/domestic violence, and stalking)
disclosed through communication including but not limited to direct conversation, email, social media, classroom papers and homework exercises.

Missouri S&T’s Title IX Coordinator is Vice Chancellor Shenethia Manuel. Contact her directly (manuels@mst.edu; (573) 341-4920; 113 Centennial Hall) to report Title IX violations. To learn more about Title IX resources and reporting options (confidential and non-confidential) available to Missouri S&T students, staff, and faculty, please visit http://titleix.mst.edu.

**COURSE SCHEDULE:**

<table>
<thead>
<tr>
<th>Module</th>
<th>Week</th>
<th>In-Class</th>
<th>Out of Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Introduction</td>
<td>1</td>
<td>Syllabus information, Team formation, Grading policy negotiations</td>
<td></td>
</tr>
<tr>
<td>Module 1: Introduction to Conduction</td>
<td>2</td>
<td>Readiness Assessment Test; Lecture</td>
<td>Chapter 1; Chapter 2, 1-2.3; Chapter 3.1, 3.2, 3.4</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>In-Class Concept Problems</td>
<td>Homework 1</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>In-Class Application Problems</td>
<td>Homework 2; Exam 1</td>
</tr>
<tr>
<td>Module 2: Convection</td>
<td>5</td>
<td>Readiness Assessment Test; Lecture</td>
<td>Chapter 5.1-5.7, 5.10; Chapter 6.1-6.3; Chapter 7</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>In-Class Concept Problems</td>
<td>Homework 3</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>In-Class Application Problems</td>
<td>Homework 4; Exam 2</td>
</tr>
<tr>
<td>Module 3: Radiation</td>
<td>8</td>
<td>Readiness Assessment Test; Lecture</td>
<td>Chapter 11</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>In-Class Concept Problems</td>
<td>Homework 5</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>In-Class Application Problems</td>
<td>Homework 6; Exam 3</td>
</tr>
<tr>
<td>Module 4: Heat Exchangers</td>
<td>11</td>
<td>Readiness Assessment Test; Lecture</td>
<td>Chapter 10</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>In-Class Concept Problems</td>
<td>Homework 7</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>In-Class Application Problems</td>
<td>Homework 8; Exam 4</td>
</tr>
<tr>
<td>Module 5: Advanced Conduction</td>
<td>14</td>
<td>Readiness Assessment Test; Lecture</td>
<td>Chapter 2.4, 2.5; Chapter 3.3, 3.5, Chapter 4</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>In-Class Concept Problems</td>
<td>Homework 9*</td>
</tr>
</tbody>
</table>

* Homework 9 will require solving problems by writing code in MATLAB, C++, FORTRAN, or your programming language of choice
NUC ENG 5257: Introduction to Nuclear Thermal Hydraulics

TWO-PHASE FLOW IN ENERGY APPLICATIONS
NUC ENG 4257
INTRODUCTION TO NUCLEAR THERMAL HYDRAULICS
NUC ENG 5257

INSTRUCTOR:
Dr. Joshua P. Schlegel
226 Fulton Hall
Tel: 573.341.7703
Email: schlegelj@mst.edu

TEXT BOOK:

COURSE DESCRIPTION:
An introductory course for students interested in the application of fluid flow and heat transfer to energy production. Students will learn the fundamentals of the scientific method in engineering and review fundamental principles of fluid mechanics and power cycle analysis. Modeling of single-phase flows and applications to energy systems will be discussed, as will fundamentals of heat transfer in nuclear fuels and reactor systems. The fundamental challenges of two phase flows and the field equations will be introduced with examples. Mixture properties and models, void fraction correlations, and pressure drop correlations for two-phase flows will be introduced, followed by two-fluid models for multiphase flows. Fundamentals of boiling phenomena and interfacial area transport will be discussed.

COURSE OBJECTIVES:
1. Apply the scientific method to engineering problems
   A. Describe the role of experiments in modeling and design processes
   B. Describe the role of mathematical modeling in engineering decision-making
   C. Describe the fundamental principles of mathematical modeling
2. Derive and use mathematical modeling from first principles
   A. Identify the correct modeling approach, then define and apply proper averaging
   B. Identify and apply appropriate simplifying assumptions (dimensional analysis)
   C. Identify key unknowns and required constitutive relations, select appropriate constitutive relations
3. Derive and use applied simplifications of mathematical models
   A. Calculate power cycle efficiency, model basic accident scenarios
   B. Describe turbulence, calculate drag force on an object, use Bernoulli’s equation, calculate head loss
   C. Apply the First Law of Thermodynamics, calculate conduction and convection heat transfer
   D. Describe the interfacial jump and boundary conditions, identify and describe two-phase flow instabilities, calculate void fraction, calculate two-phase pressure drop, estimate boiling heat transfer, estimate critical heat flux.

What will students get out of this class?
- Improved critical thinking abilities
- Ability to translate real-world problems into engineering models
- Deeper understanding of the role of the scientific method in engineering research
- Ability to develop engineering models in a rigorous and scientific fashion
- Deeper understanding of key challenges and research topics in nuclear thermal hydraulics
Improved technical communication ability
Excitement about nuclear thermal hydraulics

GRADING POLICY:
Final grades will be assigned as in Table 1. These grades will be a weighted average of exam and homework scores, with the weights given in Table 2 or Table 3, depending on the course you have enrolled in.

Table 1: Final Grade Assignments

<table>
<thead>
<tr>
<th>Score</th>
<th>Excellent Performance in the Class</th>
<th>A</th>
<th>85-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>Good Performance in the Class</td>
<td>B</td>
<td>75-84</td>
</tr>
<tr>
<td></td>
<td>Acceptable Performance in the Class</td>
<td>C</td>
<td>56-74</td>
</tr>
<tr>
<td></td>
<td>Poor Performance in the Class</td>
<td>D</td>
<td>50-64</td>
</tr>
<tr>
<td></td>
<td>Failed to Meet the Minimum Class Requirement</td>
<td>F</td>
<td>0-49</td>
</tr>
</tbody>
</table>

*This is a guarantee. Any student who receives above an 85 will receive an A under all circumstances. However I reserve the right to curve the class (reducing the cutoff for an A to 75, for example) when appropriate.*

Table 2: Final Grade Weighting, NE 5257

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exams (4)</td>
<td>50%</td>
</tr>
<tr>
<td>Homework</td>
<td>20%</td>
</tr>
<tr>
<td>Research Assessment - Rough Draft</td>
<td>15%</td>
</tr>
<tr>
<td>Research Assessment - Final Draft</td>
<td>15%</td>
</tr>
</tbody>
</table>

Table 3: Final Grade Weighting, NE 4257

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exams (4)</td>
<td>60%</td>
</tr>
<tr>
<td>Homework</td>
<td>40%</td>
</tr>
</tbody>
</table>

**HOMEWORK AND EXAMS:**

- Homework will be due one week from the date it is assigned.
- It will be turned in via a quiz on Canvas.
- Two attempts can be made for each homework, to allow you to correct any mistakes.
- Each homework will consist of five problems worth 20 points each. One will be a multi-part short answer problem on fundamental concepts and definitions, the other four will be analysis problems.

Homework tips:

- Be mindful of significant digits.
- Always double-check your units and conversions. You can often work out how to solve a problem just by looking at the units, and mistakes in your work can often be found by checking the units of your solution against the expected units.
- Make sure to read the problem carefully, and answer the question correctly.

Exams:

- Exams will be given in class.
- One page (front and back) of notes will be allowed for each student on each exam. I don’t expect memorization; I expect that you will understand how to use the equations.
- Bring a calculator for the exams in addition to your notes.
RESEARCH ASSESSMENT PAPER:

Graduate students will be expected to prepare a research assessment paper on a topic within two-phase flows. This project will count for 30% of the final grade. The instructor will select a paper for all students in the class to evaluate. Students will be required to

1) Use the knowledge and analytical techniques gained during this course to evaluate the research presented in the paper.
2) Prepare a short report detailing their analysis of the paper.
   a. The rough draft of the report will be due the first class back from Spring Break. The instructor will provide comments and feedback prior to submission of the final draft.
   b. The final draft will be due Friday of finals week at midnight.

The report should contain the following sections:
1) Abstract
2) Introduction describing the research problem, the importance of the research problem, and why this particular paper was chosen.
3) Summary of the selected research paper
4) Analysis of the research methodologies in the selected paper, with emphasis on evaluating methods and suggesting improvements.
5) Analysis of the results and conclusions in the paper.
6) Conclusions regarding the methods and results of the paper
7) References, to include proper citations of all publications referenced in the report.

A sample format and grading rubric will be posted on Canvas for students to access. Formatting requirements include:
- Font: Times New Roman, 14 point, 1.5 spacing (CTRL+5 in MS Word)
  o Title may be a larger size
- One-inch margins
- Number each page
- Primary section headings should be bolded. Secondary headings should be italicized. Tertiary headings should be formatted normally. All headings should be numbered.
- Any figures/images should be of sufficient quality that they are clearly visible
- Please see the rubric for additional requirements

ATTENDANCE AND PARTICIPATION:

Participation in class, and therefore attendance, is important to developing the skills necessary to succeed in any course. Not all of the important material will be included in the presentation slides; a good deal will be presented and discussed only in class. That said, attendance will not be taken in this class. You are responsible for your own attendance. If you must miss class for some reason (other coursework, family emergency, sick, etc) please inform the instructor prior to, or as soon as possible after, the missed class to make arrangements related to missed material.

It is expected that you will be respectful during class periods. Please keep outside distractions to a minimum. Do not engage in side conversations with other students. Electronics in the classroom are encouraged, but don’t let them become a distraction. Keep cell phones and tablets on silent.

CANVAS:

Lecture presentations, homework assignments, supplemental material, and grades will be posted on Canvas in a timely fashion. Please note that the lectures do not contain all of the necessary information, so these files are not a substitute for attending lectures. Follow your progress, and speak to the instructor if you believe a grade was reported incorrectly or if you are concerned about your progress. Make sure to bring in your graded work if you believe a grade was reported incorrectly.

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http://registrar.mst.edu/academicregs/index.html

The student council honor code can be found at http://stuco.mst.edu/about/honor.shtml. The honor code highlights two important topics: honesty and respect.

Honesty is the effort to be truthful. When your instructor asks for your own work, make sure you turn in your own work. Trying to pass off the work of another student, past or present, as your own work is dishonest. If you borrow ideas from someone else, make sure you give credit where credit is due: cite the work properly.

Respect yourself enough to believe that you can do the work on your own, and enough to want to be a better person intellectually and ethically. Fundamentally, cheating shows a profound lack of self-respect. Respect your fellow students enough to make sure that the assessments are a fair evaluation of everyone’s own ability. Remember that if one person is dishonest it can affect the entire class. Respect other students’ study habits. Respect your instructors. Always be professional in your interactions with other students, members of the faculty, and University staff.

**DISABILITY SUPPORT SERVICES:**
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## TENTATIVE SCHEDULE (SUBJECT TO CHANGE):

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unit 0: Course Introduction and Fundamentals of Nuclear Thermal Hydraulics</td>
</tr>
<tr>
<td>2</td>
<td>Unit 1: Integral Analysis</td>
</tr>
<tr>
<td>3</td>
<td>Unit 1: Integral Analysis</td>
</tr>
<tr>
<td>4</td>
<td>Unit 1: Integral Analysis</td>
</tr>
<tr>
<td>5</td>
<td>Unit 1: Integral Analysis</td>
</tr>
<tr>
<td>6</td>
<td>Unit 2: Elementary Fluid Mechanics</td>
</tr>
<tr>
<td>7</td>
<td>Unit 2: Elementary Fluid Mechanics</td>
</tr>
<tr>
<td>8</td>
<td>Unit 2: Elementary Fluid Mechanics</td>
</tr>
<tr>
<td>9</td>
<td>Unit 2: Elementary Fluid Mechanics</td>
</tr>
<tr>
<td>10</td>
<td>Unit 3: Elementary Heat Transfer</td>
</tr>
<tr>
<td>11</td>
<td>Unit 3: Elementary Heat Transfer</td>
</tr>
<tr>
<td>12</td>
<td>Unit 3: Elementary Heat Transfer</td>
</tr>
<tr>
<td>13</td>
<td>Unit 4: Mixture Models for Multiphase Flows</td>
</tr>
<tr>
<td>14</td>
<td>Unit 4: Mixture Models for Multiphase Flows</td>
</tr>
<tr>
<td>15</td>
<td>Unit 4: Mixture Models for Multiphase Flows</td>
</tr>
</tbody>
</table>
ADVANCED NUCLEAR THERMAL HYDRAULICS
NUC ENG 6257

INSTRUCTOR:
Dr. Joshua P. Schlegel
226 Fulton Hall
Tel: 573.341.7703
Email: schlegelj@mst.edu

TEXT BOOK:
This course is not based around a particular textbook. Much of the information discussed in class is derived from research papers, Ph.D. theses, and a variety of textbooks. Where possible some of these sources have been uploaded to Canvas in the form of ‘further reading’ suggestions. However the content comes from numerous sources; it will be up to students to investigate the available scientific literature for further detail, although the instructor can provide some recommendations.


COURSE DESCRIPTION:
An advanced course for students interested in the application of fluid flow and heat transfer to energy production. The course begins with a brief review of fundamental concepts covered in NUC ENG 5257. This will be followed by a detailed discussion of two-fluid models for multiphase flows, their applications, and the key modeling and research challenges involved. The course will then move into an applied discussion of the applications of multiphase flow models to the dynamics of multiphase flows, focusing on phenomena of interest in nuclear reactor applications. Scaling of multiphase flow systems and the design of scaled experiments will be discussed with case studies, and students will be introduced to the numerical techniques used to solve most of the complex problems faced in analysis of nuclear thermal-hydraulics. Finally, students will be introduced to problems of interest in nuclear reactor safety calculations such as fuel melting and direct containment heating.

COURSE OBJECTIVES:
1. Describe and discuss the major multiphase flow models
   A. Identify the benefits and drawbacks of various models
   B. Describe the physical significance of the various equations and terms, and their effect of flow behavior
   C. Decide which model is most appropriate for a given thermal-hydraulic problem
2. Identify and discuss the key dynamic phenomena of interest in nuclear reactor systems
   A. Identify, compare, and evaluate common modeling approaches
   B. Discuss the significance of key phenomena in nuclear reactor systems
3. Scale multiphase flow systems
   A. Identify key scaling parameters
   B. Develop important scaling ratios
   C. Use scaling parameters to design experiments and characterize distortions
4. Compare and contrast solution methods for multiphase flow models
   A. Evaluate various analysis and numerical solution techniques
   B. Select the most appropriate solution technique
   C. Write a computer code to solve the appropriate model

What will students get out of this class?
- Improved critical thinking abilities
- Ability to translate real-world problems into engineering models
- Deeper understanding of the role of the scientific method in engineering research
J.P. Schlegel

- Ability to design scaled experiments for multiphase flows
- Ability to develop engineering models in a rigorous and scientific fashion
- Deeper understanding of key challenges and research topics in nuclear thermal hydraulics
- Improved technical communication ability
- Excitement about nuclear thermal hydraulics

**GRADING POLICY:**

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<table>
<thead>
<tr>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-100</td>
<td>Excellent Performance in the Class</td>
</tr>
<tr>
<td>75-84</td>
<td>Good Performance in the Class</td>
</tr>
<tr>
<td>56-74</td>
<td>Acceptable Performance in the Class</td>
</tr>
<tr>
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</tr>
<tr>
<td>0-49</td>
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</table>

*This is a guarantee. Any student who receives above an 85 will receive an A under all circumstances. However I reserve the right to curve the class (reducing the cutoff for an A to 75, for example) when appropriate.*

Table 2: Final Grade Weighting, NE 5257

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Exams (2)</td>
<td>20%</td>
</tr>
<tr>
<td>Homework (8)</td>
<td>80%</td>
</tr>
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</table>

**HOMEWORK AND EXAMS:**

- Homework will be due one week from the date it is assigned.
- Use engineering paper or plain white paper.
- **Write legibly** and large enough to read clearly. Work that cannot be read/followed will not receive points.
- **Work neatly.** Clearly specify the given information, what you are solving for, any engineering assumptions that are required, and any important equations that will be used. If necessary, include a neat sketch of the problem. Solve the problem in an organized, logical fashion.
- **Show** all your work to receive all the credit.

Homework tips:

- Be mindful of **significant digits**.
- Always double-check your **units and conversions**. You can often work out how to solve a problem just by looking at the units, and mistakes in your work can often be found by checking the units of your solution against the expected units.
- Make sure to read the problem carefully, and answer the question correctly.

Exams:

- Exams will be given in class.
- One page (front and back) of notes will be allowed for each student on each exam. I don’t expect memorization; I expect that you will understand the equations and concepts.
- Do not bring a calculator for the exams, it will not be necessary.

**ATTENDANCE AND PARTICIPATION:**

Participation in class, and therefore attendance, is important to developing the skills necessary to succeed in any course. Not all of the important material will be included in the presentation slides; a good deal will be presented and discussed only in class. That said, attendance will not be taken in this class. You are responsible for your own attendance. If
you must miss class for some reason (other coursework, family emergency, sick, etc) please inform the instructor prior to, or as soon as possible after, the missed class to make arrangements related to missed material.

It is expected that you will be respectful during class periods. Please keep outside distractions to a minimum. Do not engage in side conversations with other students. Electronics in the classroom are encouraged, but don’t let them become a distraction. Keep cell phones and tablets on silent.

**CANVAS:**
Lecture presentations, homework assignments, supplemental material, and grades will be posted on Canvas in a timely fashion. Please note that the lectures do not contain all of the necessary information, so these files are not a substitute for attending lectures. Follow your progress, and speak to the instructor if you believe a grade was reported incorrectly or if you are concerned about your progress. Make sure to bring in your graded work if you believe a grade was reported incorrectly.

**ACADEMIC DISHONESTY:**
A student enrolling in the University assumes an obligation to behave in a manner compatible with the University's function as an educational institution. Page 33 of the Student Academic Regulations handbook describes the student standard of conduct relative to the System's Collected Rules and Regulations section 200.010, and offers descriptions of academic dishonesty including cheating, plagiarism or sabotage. Please review the Student Academic Regulations in the address above. Plagiarism, cheating, and other forms of academic dishonesty will result in a failing grade for the assignment and possibly the course.

http://registrar.mst.edu/academicregs/index.html

The student council honor code can be found at http://stuco.mst.edu/about/honor.shtml. The honor code highlights two important topics: honesty and respect.

Honesty is the effort to be truthful. When your instructor asks for your own work, make sure you turn in your own work. Trying to pass off the work of another student, past or present, as your own work is dishonest. If you borrow ideas from someone else, make sure you give credit where credit is due: cite the work properly.

Respect yourself enough to believe that you can do the work on your own, and enough to want to be a better person intellectually and ethically. Fundamentally, cheating shows a profound lack of self-respect. Respect your fellow students enough to make sure that the assessments are a fair evaluation of everyone’s own ability. Remember that if one person is dishonest it can affect the entire class. Respect other students’ study habits. Respect your instructors. Always be professional in your interactions with other students, members of the faculty, and University staff.

**ACCESSIBILITY AND ACCOMMODATION:**
It is the university’s goal that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please contact Disability Support Services at (573) 341-6655, dss@mst.edu, or visit http://dss.mst.edu/ for information, or go to mineraccess.mst.edu to initiate the accommodation process.

*Please be aware that any accessible tables and chairs in this room should remain available for students who find that standard classroom seating is not usable.*

**CONCERNS AND COMPLAINTS:**
If there are concerns of complaints please talk to me and I will try to respond your worries and concerns. If you feel you cannot talk with me, please feel free to talk to the Department Chair, Dr. Hyoung K. Lee (leehk@mst.edu).

**TITLE IX:**
Missouri University of Science and Technology is committed to the safety and well-being of all members of its community. US Federal Law Title IX states that no member of the university community shall, on the basis of sex, be excluded from participation in, or be denied benefits of, or be subjected to discrimination under any education program or activity. Furthermore, in accordance with Title IX guidelines from the US Office of Civil Rights, Missouri S&T requires that all faculty and staff members report, to the Missouri S&T Title IX Coordinator, any notice of sexual
harassment, abuse, and/or violence (including personal relational abuse, relational/domestic violence, and stalking) disclosed through communication including but not limited to direct conversation, email, social media, classroom papers and homework exercises.

Missouri S&T’s Title IX Coordinator is Vice Chancellor Shenethia Manuel. Contact her directly (manuels@mst.edu; (573) 341-4920; 113 Centennial Hall) to report Title IX violations. To learn more about Title IX resources and reporting options (confidential and non-confidential) available to Missouri S&T students, staff, and faculty, please visit http://titleix.mst.edu.

**TENTATIVE SCHEDULE (SUBJECT TO CHANGE):**

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<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Notes</th>
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<tr>
<td>1</td>
<td>Module 0: Course Introduction and Review</td>
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<td>2</td>
<td>Module 1: Two-Fluid Models</td>
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<td>Module 1: Two-Fluid Models</td>
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<td>4</td>
<td>Module 1: Two-Fluid Models</td>
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<td>5</td>
<td>Interlude - Papers and Presentations</td>
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<tr>
<td>6</td>
<td>Module 2: Multiphase Flow Dynamics</td>
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<td>Module 2: Multiphase Flow Dynamics</td>
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<td>9</td>
<td>Module 3: Scaling and Numerical Analysis</td>
<td>Exam 1</td>
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<td>15</td>
<td>Module 4: Accident Analysis</td>
<td>Exam 2</td>
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APPENDIX E – SELECTED STUDENT EVALUATION COMMENTS

**Fall 2014:**

*NUC ENG 6207:*

Excellent knowledge of material and availability outside of class. Lecture content did not always correspond with homework assignments. Instructor spent a lot of time on detailed derivations of various equations and correlations and not so much time on practical application.

Excellent teaching capabilities. Very hard working and cares about his students. More importantly stick to the rules which is of great commendation.

The instructor is very concerned with our learning progress. Although this is the first time for the instructor to teach this course, the instructor tried his best to teach well. Like each time after the test, the instructor would ask for our course evaluations back.

Before lecturing on a topic he should build some foundation on it like what is it and how it is relevant etc.

Experience needed for the course. Teaching skills play important role since this is an advanced version of three courses combined.

Course was well structured and aimed to give as much knowledge as possible. There was no hand on realization on the subject matter.

It is an advance course such that assuming student to have background knowledge. There should be more examples of problem solving.

Set prerequisites for the course - thermodynamics, fluid mechanics and heat transfer, spend less time on basics and explain the advanced concepts in depth while relating to those basics in between, spend a bit more time on fluid mechanics, transport equations and less on the initial thermodynamics. Also, u could consider distributing the notes or making PPT of equations and explaining directly from them instead of writing it on the board- saves a lot of time.

I do not know if it is possible to separate this course into two parts and then teach this course during two semesters. But I think that would be better for students to learn.

**Spring 2015:**

*NUC ENG 4257/5257:*

The professor was well organized and effectively presented course material necessary for a good understanding of two phase flow.

Strengths: Concerned about the students learning and understanding of the material. Weaknesses: Inexperienced in teaching practices, and different learning styles. Information was often scattered and wasn't clear to the students what the connections were.

Strength: Definitely knows the course material and comes prepared with slides/notes ready to go for the class Weakness: The fact that he knows the material so well causes him to skip explanations of intermediate steps that someone who hasn't taken fluid mechanics in a year may not understand fully; Sometimes goes through the notes and material too quickly in class Strengths- explaining and reviewing material in multiple ways to help students understand the
Instructor is very concerned about students understanding and enjoys the topic. Once the formulas start getting complex like in 2-fluid or mixture models, the explanation of the terms in continuity, momentum, energy equations became quicker and harder to keep up with. I only took half of a page of notes when I should have taken 3 because he talked so fast. He is generally available during office hours and willing to cover anything a student may have missed.

Allow time for professor to get better at teaching. And have the professor be willing and excited to learn how to teach, as he currently is. Less test, more projects! It is more interesting use models in real life applications than memorizing a bunch of equation for a test. At some point during the semester, I found myself cramming thousand of equations and mathematical symbols.

**Fall 2015:**

**NUC ENG 4496:**
The instructor did well to politely point out issues with groups designs. Plus the fact that the instructor was willing to re-evaluate his grading policy and correct any errors he made on his behalf. Also kept the course fairly light and fun given the magnitude of the course. It also would have been nice to allow more time for students to come up with design ideas. Though class time is valuable it would be nice to send something out before classes started in order to give students time to maul over ideas.

I would make sure to talk to all the groups each class period since time is very important during this class. It seemed like some groups were excluded during some of the classes even though the professor talked about flaws in group designs it would have been nice to hear some of the positives of the design.

Instead of just explaining why one method won’t work try to come up with a way that method would work to see if maybe there was a miscommunication so that things are not contradicted as much.

**NUC ENG 3221:**
The most kind and caring professor I have ever had. He truly wants all of his students to succeed. The instructor is obviously intelligent, with great understanding of the material. However, I think sometimes he relies on notes too much and gets in a routine of simply rolling through what needs to be learned. He does however make up for this with his concern for each person's understanding of the material through the use of office hours and answering any and all questions.

Dr. Schlegel really does care about his students and wants them to learn and succeed; however, there was a block in communication that prevented much of the material comprehension.

Invests the time to cover examples in detail. Works clearly and easy to follow. Good communicator. Dr. Schlegel was willing to improve on his teaching skills and in the way he taught constantly, which was one of his biggest strengths. He was not super great at describing things in class in
J.P. Schlegel

a way that was both interesting and engaging. If you asked for help, or attended LEAD, he was
good at describing things outside of class.
As much as the students may not like it, you should force participation in class to break the
monotony.
I would suggest more practice problems and more lessons on the conceptual ideas of each topic
rather than just textbook recitation.
Very tough, made me push hard to earn a grade
This course is difficult, requiring a lot of focus and studying. However, the educational payoff
through understanding is immense.
Lectures were too fast. Examples were great but at times hard to follow. During examples skipping
steps made it hard to follow.
Understand that it was your first semester teaching, and that is more difficult than students will
give you credit for. I understand your mindset with creating the tests where there is a larger
range of the distribution, but I don't think it's the best method for learning the material for "real
world" situations. The test problems (and some homework problems) are so complex that my
understanding of the principles of fluids becomes jumbled, but that's partially because I didn't
devote as much time to the class as I could have to fully understand the course. Basically, I
would recommend to make sure that you teach at a level where the basic principles are
solidified for everyone before complex problems are addressed.
Go slower through the lecture material. Keep doing examples. they were great!
It's a great class to prepare us for real world problems but sometimes overwhelms a person never
seeing the content before.
This course is difficult, requiring a lot of focus and studying. However, the educational payoff
through understanding is immense.
I felt that the course held a LOT of very important and vital information.

Spring 2016:
NUC ENG 3223:
The instructor really cares about how the students understand the material. He works hard to make
sure that there is help available to students if they are not understanding the concepts and is
also understanding when students are in situations that make turning in homework on time a
challenge. One of the weaknesses, though, is that the content taught in the class is very low
level compared to the knowledge required in the homework.
The instructor is very passionate about the material and knows it very well. I sometimes had trouble
completing the examples in class as quickly as the instructor.
Posting practice problems on blackboard was great! I used them a lot when studying and working
on homework problems.
Since last semester, Dr. Schlegel has improved his teaching methods significantly. He's trying to
figure out effective ways to teach, and he is clearly making progress. He constantly asks for
feedback from his students throughout the semester, and when it's provided, he implements a
correction to his methods promptly. He seems to genuinely care that we understand the
material. He's easy to arrange an appointment with to get help or go over mistakes with. Also,
he hosts LEAD sessions once a week to assist students with filling gaps in their knowledge and with homework. My only complaint would be the length of the exams. I consider myself a quick worker, and I was barely finishing (or barely not finishing) the exams. I heard from many other students that they didn't get close to finishing each exam.

Clear communication. Works out examples and highlights most important material. Provides information on theory, applications, correlations, and different numerical/empirical/analytical solutions.

Very knowledgeable regarding material, but relies too heavily on powerpoints
Very well prepared Very strong scientifically. communicat
I think that you expected us to pick up concepts that are totally new to us, that are fairly complex in a very short amount of time. I think that you sort of "shot gunned" the class. You threw a lot of information at us quickly, and not a lot of it stuck to be honest.

Dr. Schlegel really knows what he is talking about. It is clear that he is able to understand and communicate many facts and pieces of information over a broad range of topics. I think that his good knowledge of the material can really aid in the explanation of certain topics. I do, however, think that often times he tries to explain things in a text book manner when students could use a simplified version, or just the essentials for many topics.

The instructor could spend more time focusing on example problems and less time focusing on things that could be easily learned from the textbook.
Spend more time explaining concepts than going over multiple equations.
I really believe that there is a little too much information in the powerpoints used in class. I think students benefit with a concise explanation of the reason of a problem, then the physics/math of a problem, then a summary of the ways to solve the problem. The book does alot of behind the scenes explanations so it isn't necessary to include all of this during class.

I liked the group involvement of solving problems. As long as everyone in the group participates, I think this would be very effective.

A forgiveness matrix i.e. a way to replace a test grade, extra credit, or the ability to re-do some homework or replace a homework grade. In your fluids class we did a project. I actually enjoyed this and this helped me realized how fluid mechanics was used in industry and this was a good way to help our grades as well. I would've enjoyed a small project in heat transfer so that we could see better how it applies and get some hands-on experience with it.

Introduce the concepts, show them with in depth examples. I think if you are relying too much on power point, it causes you to go too fast. Sit in on other professors. In my opinion, Dr. Mueller is the best in the department. He teaches slowly and in depth, and he doesn't even use you power point. I know that makes teaching more difficult, but it forces you to slow down and emphasis the most important info.

Make the course more related to nuclear material, rather than being so broad. It will reduce the amount of material that needs to be taught and allow for far more effective teaching.

**Fall 2016:**

**NUC ENG 3221:**

Dr. Schlegel is very concerned for his students, but sometimes I feel like he has difficulty explaining the contents of the course, possibly because he expects us to already understand more than we do. Perhaps, near the beginning of the course, he could give out a short quiz on some of the notation and problem solving methods we use in this class to get a feel for how much of the class understands from previous courses. Also, it would be great if he could
explain things a bit slower; especially near the beginning of the course a walk-through of all
the equations would be very helpful.
He cares about the students and also wants to convey the material as clearly as possible. The
group mechanic of the course was highly appreciated and it did help distribute the work and
simulate a more cooperative environment. Of the 3 exams, I did enjoy the last exam the most
due to the group portion. It made it a little easier to do better while also allowing you to see,
in a sense, how you did on the individual portion. Personally I would prefer a group exam
and not the individual portion, though I could see that being harder to justify, especially if the
work in a group is not evenly distributed.
Dr. Schlegel is an excellent professor but sometimes doesn't fully explain a topic in class.
However, if you ask him for help in LEAD or office hours he will more than willingly
explain it to you fully and in different ways to make sure you know the material. He enjoys
the class which makes it much easier to understand it and to want to learn the subject matter.
Super nice guy, would do anything to help his students. Really hard class, hard material, hard
homeworks. Professor Schlegel does his very best to communicate the info to the students in
a meaningful way. One great strength of the instructor is he seems to know everything about
anything you ask him about. I have yet to ask a question he didn't know the answer to.
Dr. Schlegel is somewhat new to MS&T Nuclear department, so it is understandable that some
of the material that he taught was somewhat looked over, and assumed that students knew.
He was very helpful in office hours and in class, as well as his ability to want to learn how to
teach his students the material better.
My main gripe with the class was that the slides for the class were posted online, which is great!
The problem was that they were PDF documents and not PowerPoints so there were
instances where a picture would be maximized on the screen due to an animation in the
PowerPoint and cover other information on the slide. That would be ok if I could move the
picture but I can't if it's a PDF file. Change PDF files to PowerPoints.
More focus on the "Why" of the steps taken. This course has a lot of new material and it can be
extremely hard to follow the steps. I had a very difficult time figuring which formulas to
even start with because I never fully understood why one might be picked over another.
Mainly, just slow down a bit.
For the last test we did a review where we were in our groups and had problems to work on and
then compared answers for each problem. I enjoyed this activity and think it would be helpful
to have done this before every test. At first I was worried about the group homework but as
the semester went on I enjoyed the fact that I had an entire group to help me with the
homework.
Lectures are presented well and group homework is useful. The exams were unnecessarily
difficult.
I would try to suggest trying to explain or compare certain concepts to everyday things more
often would improve comprehension. Some of the concepts seemed to be very technical so it
made it harder to try to be motivated to learn them or harder to try to understand its
significance. Relating it to something everyday or showing where it becomes important
would help, at least me, be more motivated and able to remember the concepts that we were
learning.
I thought the change in homework (from more difficult/less problems to less difficult/more
problems) was an excellent step. It helped me get more practice on a wider array of ideas. I'm
not totally sure that doing it in teams is a great idea though, but that mostly depends on the team.
Use a textbook that's less dense and make the exams more reasonable.

**NUC ENG 5257**: 
Prof. is very friendly, polite and gentle which help us to communicate with him effectively. I think that the addition of more visuals explaining the meaning of certain terms in the equations as well as explaining the variables themselves would be highly beneficial. Also in the slides I think when you take a picture and blow it up or put pictures over the stuff in the slides it would be easier for the students if those were on a separate slide.

I learned a lot about things I didn't know and it also reinforced the things I had learned before but had forgotten.

This course gives a very good basic understanding of this field. The lecture materials are very resourceful.

More time on tests would be appreciated or making the tests slightly easier. I felt I didn't have enough time to think about the problem.

**Spring 2017:**

**NUC ENG 3223**: 
Dr. Schlegel is one of the hardest working professors I have ever met. He cares more about our understanding and learning than most of the professors I have had thus far in my academic career. He continuously looked at performance in the course and asked us what needed to change to improve our instruction. It was an amazing feat of humility and coordination that Dr. Schlegel took the time to say "Things are not going well, what do I need to do better?" He challenges us. His classes are not easy whatsoever. He tries to incorporate modelling tutorials and assignments into class that will be very helpful with senior design and probably modelling real world problems. This university needs more professors with Dr. Schlegel's level of expertise and more importantly his drive. His passion for both research and his students is nearly unmatched on this campus and it should be the universities top priority to keep him and teachers like him around for the long term future.

I believe that, in time, he could be a very good teacher. Unfortunately, as it stands right now, I cannot recommend him. Dr. Schlegel is an extremely smart man, but with that he has a hard time understanding when his students don't understand. Just because I have read the book and watched the lecture videos does not mean I understand the material perfectly.

Has difficulty communicating how to accomplish goals in an easy to grasp manner

He makes himself available for office hours and LEAD sessions. He listens to his students when they give him feedback. He is excellent at explaining problems when he takes a step back and focuses on the content as well as the math but there is not always time for this.

Sometimes, taking the extra time to clearly explain the most important/fundamental items would be extremely helpful.

Very knowledgeable on the subject. However, this can at times be a weakness as well as you skip
parts that likely seem very simple to you, but it leaves us with a gap in the knowledge which can snowball as a lot of concepts help build on each other.

He's not great at reading his students and being able to tell that they're not understanding a topic.

I enjoyed CFD, I would like to see that continue to improve. maybe a mini lecture or two on it. perhaps even lead sessions devoted to it.

Discuss the thought process one should go through when approaching problems in each module.

It was difficult to derive a thought process (algorithm for completion) for the initial modules.

The lecture videos do a good job of introducing the concepts of the course, but do not tell us much about how to use the concepts, which I believe was what the example problems worked in class were meant to achieve. However, having the students work problems is not the same as teaching. We must be taught the how to apply the concepts to problems before we can either fully understand the concepts or work problems on our own. Here is my suggestion for how to change Dr. Schlegel's teaching style with minimum alteration to the course as it already is:

When we are given a problem to work in class, start by giving the teams a couple minutes to look at the problem and form a plan of how to complete the problem. Then, Dr. Schlegel should go over an outline of how to solve general problems similar to the one given, and the steps needed to solve the given problem in particular. Lastly, each team should work through the problem using the steps provided. This way, if a team did not know how to start a problem, or if their idea of how to solve the problem was wrong, it can be corrected before the problem is complete. This would also provide some instruction on how to solve similar problems if they are encountered in the homework or the test.

I would suggest the schedule for a new module to start with a take home RAT that could be more extensive. The first class would then be a lecture of the concepts described in the module itself with some minor examples.

The team test should be one multi-part question that forces team work instead of the same test again.

Continue to use teams because having other people to consult with about homework and RATs was very helpful.

**NUC ENG 5257:**

Good at motivating, great analogies and connecting class content to applications, always available to help. Too much focus on PowerPoint.

The instructor is very strong in the field but the course is very dense. The home works were long, but very useful. Very cooperative instructor.

Slow down a little on the slides. It's hard to write everything down, and most of the important content about conceptual information is spoken, not on the slides.

Including CFD lab might be helpful to the class and students as well.

**Fall 2017:**

**NUC ENG 6257:**

Your teaching style makes it really easy for me to stay engaged because it is obvious you are really
interested in the content (so I want to be interested too!). You include a mixture of teaching about the physical significance of phenomena and also how it can be modeled mathematically, which makes me think that someday when I go to use this content again, I will hopefully be able to parse out the information much easier than if it were only one or the other.

The biggest weakness I have noticed (and often been frustrated with this semester) is the communication on the homework assignments. The requirements on the homework is often unclear. Sometimes you can go a little too fast. I think the slides get too bogged down with equations without having the final analysis of what the equations mean. I think the instructor communicates the ideas of the class well despite this.

Very enthusiastic in teaching and tried to provide materials which help student understand the contents of the lecture. Those effort motivated me a lot. Seems to have an excellent understanding and grasp of the subject matter. Brings in many good references and examples to illustrate his points. Occasionally, he moves too quickly for students to have time to gain an understanding of the topic while he is presenting it. It is also difficult to sift out the important information from the less important.

Strengths: has a deep understanding of material. Truly enjoys the material. Is willing to take suggestions for improvement and is actively trying to improve his way of teaching.

Weaknesses: the class moves a little quickly, sometimes too quickly to attempt to keep up while taking notes.

Make written notes available to students, and if you record lectures like you mentioned you might, that would be VERY helpful.

I would suggest slowing down during important pieces of the presentation. This will allow students to form an understand as well as make note of importance.

It feels like the content is complex enough while still being understandable. I feel like I know enough to be able to read to learn more. It would have been nice to have covered more two-phase models and boiling models in depth. It also would have been cool to have covered things like condensation.

The course follows a great and logical narrative. This means that each topic seems to build on or be related to the last, and there is a decent path which students can trace out. It is difficult sometimes to comprehend all that is presented. This is because the slides used for lecture are full of information that is presented in brief, bulleted snippets. Additionally, much of the important information is spoken in class and it is hard to record all of it while trying to read slides, listen, and take notes.

There was a slight disconnect between material covered in class and the expectations for homework. Maybe in the future, the homework can be more mixed between conceptual and problem solving. While the conceptual was really nice, it was slightly disconnected from a lot of the instruction that was mathematical.

Additionally, important information could be summarized into a few conclusion slides rather than left to be spoken about during class.
Spring 2018:

NUC ENG 3223:
Dr. Schlegel really cares about becoming a better professor and always improving.
Open to constructive criticism and willing to make changes to the course immediately.
Helpful and willing to teach one-on-one. Teaching skills have improved massively in just one semester.
Everything is readily available online and even posts videos for each module on YouTube.
Made people get out of their comfort zone and work together, but communication is a little rough.
Great at preparing students for the future and describing what he expects of us. Has a little trouble explaining things in “laymen’s” terms.
Negotiated the class structure to tailor the class, makes students feel that they are being included in the conversation about their education. Something no other professor has done through my time as a student.
When answering questions, sometimes talks as if we should already know everything.
Some materials/guidance were ambiguous: test content, course schedule, and individual/team problems.
Encourages teamwork in preparation for senior design. Discusses test metrics and rough spots after each exam.
Write more neatly and slow down during lecture. Record solutions to example problems on video.
This class relies heavily on reading the book, but most students have never had to before. I don’t think any of us know how to tackle reading a textbook, other than reading 120 pages in a night, writing down definitions, and having no idea how it all goes together.
Stress that the videos cover what you really need to know for the readiness assessments.
I feel like I learned a lot and will retain a lot more of the information compared to other courses.
I actually learned something in this class that can be applied to the real world.
Digital grades (on Canvas) would be appreciated.
One of the biggest strengths of this course is having design problems that work well with the team structure.
Post homework solutions after they are due for review.

NUC ENG 4257/5257:
Tends to cover material quickly, and students can sometimes get lost.
Very excited about the material, which makes the lectures easy to follow.
Cover more in-class examples.
Papers relevant to each chapter would be helpful for students.
Very good communicator, really brings home the ideas you should take away from the class.
“Easy” homework, then “difficult” homework format is great.

Fall 2018:

NUC ENG 2001:
Sometimes assumes students know more than they do.
Spend more time explaining how iterating works
Gives a lot of useful information not covered in other classes; Would love to get more in depth into Excel and Matlab.

**NUC ENG 3221:**
Prepared for class and has lots of resources for the students, but difficult to follow in class.
Online resources were useful, well formatted, and easy to use.
The ability to work with students to determine what is best will eventually make the teaching methods effective.
If I asked a question you would always point me in the right direction without just giving me an answer which was good for my understanding.
Definitely looked out for applications of the material, providing many opportunities for problems with lots of variety and applications.
Go more slowly when discussing problems during class. Explain shortcuts more clearly.
Runs the flipped course very well, matches his style of teaching. Sometimes his answers to questions in class would be a bit confusing.
Record videos of you solving the example problems provided on Canvas with descriptions of each step.
More clearly emphasize high-priority material and go more slowly when discussing the basics.
Teaches an independent study habit to move at your own pace, but encourages to stay on track to learn the material in a timely manner.
The course is structured very uniquely, it was particularly useful to me that we worked in the same group for the entirety of the course, allowing us to determine how the team worked together.
The tests and assignments were tough and I had to understand the concepts to do well on them.
Expect the ability to solve problems numerically; the skills needed for this could have been elaborated on better.