ACADEMIC PORTFOLIO

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December 31, 2020
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PERSONAL STATEMENT

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.
- 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.
- 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 Nuclear Engineering Program and Missouri University of Science and Technology.

When I was a junior in Nuclear Engineering at Purdue University, I was struggling during the Fall semester of that year. I was working two jobs to pay room and board 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 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 tutoring a few Juniors in reactor physics 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 in 2012 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 “I think you have learned everything you can from working here, you are ready to move on”. A few months after that, in early 2014, I was hired at Missouri S&T. 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.

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. Thus far my research program has resulted in $855,000 in grants, 37 peer-reviewed journal publications and 776 citations for an h-index of 17. This is the highest h-index among all faculty in my department, and I have the highest rate of citations (citations per year) among all faculty in my department. This led to a Young Member Achievement Award from the Atomic Energy Society of Japan in 2017. 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. My teaching focuses on team-based, problem-based learning, and constructive criticisms from the students have been very helpful in adjusting my teaching methods to the needs of the learners. Over the past year my teaching evaluations have exceeded the university average score for instructors. My service activities have been focused on influencing the future development of the Nuclear Engineering Program and expanding the visibility of my research program and related activities.

J.P. Schlegel
serve as the Undergraduate Coordinator for Nuclear Engineering. In the past two years I have participated in more recruitment events than any other faculty in the program.

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 six-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.” In reviewing my tenure case, the Dean of CEC wrote in his recommendation that “A strong case has been established for superior performance in teaching, research, and service.” 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.
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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.

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 over the last 6 years. I have published a total of 37 journal publications. This number does not include a book chapter on two-phase flow in large diameter pipes, nor does it include 30 peer-reviewed conference proceedings. One was published in a journal with impact factor of 6.4. Perhaps more important than publishing is making sure that people are reading and using the work. Figure 1 also shows the rate of citations over the last 6 years. Based on data obtained from my Google Scholar profile, I have a total of 776 citations and an h-index of 17. I currently have the highest h-index and highest citation rate (citations per year) among all faculty in the Nuclear Engineering program.
Funded grants and proposals are listed in Table 1. As the table indicates, I have obtained $855,000 in funding (2014-2020). This amount does not include $495,000 from US NRC for faculty development, which was used to establish a laboratory and support preliminary research. Although I was the beneficiary of this grant, NRC rules prohibit the beneficiary from being the PI. Additional details can be found in my Curriculum Vitae, in Appendix A. I am also continuing to submit research proposals. Based on my publication and funding record, according to the Dean of CEC, I “have demonstrated outstanding scholarship in thermal hydraulics.”

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. Finally, my work has been cited by researchers in a wide range of fields and by researchers across the globe. 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. Recently the Korean Atomic Energy Research Institute (KAERI) began including a correlation I developed in their nuclear reactor safety analysis code SPACE. This work has also led to a Young Member Achievement Award from the Thermal Hydraulics Division of the Atomic Energy Society of Japan, citing my “extensive and original research contributions to the development of the interfacial area transport equation.”

The data resulting from this research 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, and the development of TRACE-T, a beta-version code which includes implementation of detailed bubble coalescence and breakup models. 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. Detailed void fraction measurements at

Table 1: Funded Research Activities

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Sponsor</th>
<th>Dates</th>
<th>PI</th>
<th>Total Funding</th>
<th>Shared Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computational Fluid Dynamics for Fusion Component Cooling</td>
<td>US DOE</td>
<td>August 2020 - December 2020</td>
<td>Dr. Joshua P. Schlegel</td>
<td>$11,680</td>
<td>$11,680</td>
</tr>
<tr>
<td>Undergraduate Scholarships in Nuclear Engineering at Missouri S&amp;T (2019-2021)</td>
<td>US NRC</td>
<td>August 2019 - July 2021</td>
<td>Dr. Joshua P. Schlegel</td>
<td>$200,000</td>
<td>$120,000.00</td>
</tr>
<tr>
<td>Graduate Fellowships in Nuclear Engineering at Missouri S&amp;T (2019-2021)</td>
<td>US NRC</td>
<td>August 2019 - July 2021</td>
<td>Dr. Ayodeji Alajo</td>
<td>$400,000</td>
<td>$120,000.00</td>
</tr>
<tr>
<td>Overhead Crane Installation and Enhancement of Distance Learning at Missouri S&amp;T</td>
<td>US DOE</td>
<td>October 2018-September 2019</td>
<td>Dr. Ayodeji Alajo</td>
<td>$250,000</td>
<td>$41,666.67</td>
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<tr>
<td>Undergraduate Scholarships in Nuclear Engineering at Missouri S&amp;T (2018-2020)</td>
<td>US NRC</td>
<td>August 2018 - July 2020</td>
<td>Dr. Hyoung-Koo Lee</td>
<td>$200,000</td>
<td>$100,000.00</td>
</tr>
<tr>
<td>Radiation Response of Phase Change Materials for Space and Nuclear Applications</td>
<td>MRC</td>
<td>April 2018 - July 2018</td>
<td>Dr. Joshua P. Schlegel</td>
<td>$8,500</td>
<td>$8,500</td>
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<tr>
<td>Scholarships in Nuclear Engineering at Missouri S&amp;T (2017-2019)</td>
<td>US NRC</td>
<td>August 2017 - July 2019</td>
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<td>$200,000</td>
<td>$42,877</td>
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<td>Scholarships in Nuclear Engineering - III</td>
<td>US NRC</td>
<td>August 2016 - July 2018</td>
<td>Dr. Hyoung-Koo Lee</td>
<td>$200,000</td>
<td>$60,000</td>
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<tr>
<td>Improved Drift-Flux Model for Rod Bundles at Elevated Pressures</td>
<td>Institute of Nuclear Safety Systems, Inc. (Japan)</td>
<td>November 2015 - February 2016</td>
<td>Dr. Joshua P. Schlegel</td>
<td>$30,000</td>
<td>$30,000</td>
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<tr>
<td>Scholarships in Nuclear Engineering - II</td>
<td>US NRC</td>
<td>August 2015 - July 2017</td>
<td>Dr. Hyoung-Koo Lee</td>
<td>$200,000</td>
<td>$60,000</td>
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<tr>
<td>Experimental Validation of Models and Simulations in Nuclear Systems</td>
<td>University of Missouri Research Board</td>
<td>February 2015 - January 2018</td>
<td>Dr. Joshua P. Schlegel</td>
<td>$75,000</td>
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<td>Condensation Heat Transfer Experiment and Scaling</td>
<td>Small Modular Reactor Research and Education Consortium</td>
<td>August 2014 - June 2015</td>
<td>Dr. Shoaib Usman</td>
<td>$90,000</td>
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<td>Graduate Fellowships in Nuclear Engineering at Missouri S&amp;T</td>
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<td>August 2014 - June 2021</td>
<td>Dr. Hyoung-Koo Lee</td>
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<td>Scholarships in Nuclear Engineering</td>
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<td>Code Development for Bubble Coalescence and Breakup - II</td>
<td>Chevron Energy Technology</td>
<td>April 2014 - December 2014</td>
<td>Dr. Takashi Hibiki (Purdue University)</td>
<td>$120,000</td>
<td>$46,500</td>
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<td>Interfacial Area Transport Study in Gas-Dispersed Flow</td>
<td>Bettis Atomic Power Laboratory</td>
<td>August 2014 - August 2018</td>
<td>Dr. Mamoru Ishii (Purdue University)</td>
<td>$615,000</td>
<td>$153,750*</td>
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<tr>
<td>Code Development for Bubble Coalescence and Breakup</td>
<td>Chevron Energy Technology</td>
<td>April 2013 - December 2013</td>
<td>Dr. Takashi Hibiki (Purdue University)</td>
<td>$100,000</td>
<td>$50,000*</td>
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<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>$855,513</td>
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</table>

* 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.
various points along the suction piping for ECCs pumps were used by Westinghouse Nuclear to justify the safety of the systems to the NRC in response to Generic Letter 2008-1. The results were used by NRC to create training materials for nuclear plant operators. INSS implemented the resulting model in their custom version of RELAP5. The results of the steam condensation study will be used by the Consortium members in their licensing applications to the US NRC.

Last, but not least, the mentoring of PhD candidates is an important part of our research mission. In 2018 my first PhD student graduated. He is now the Director of Engineering at Phase Change Energy Solutions, Inc., a premier engineering design firm developing thermal management solutions across several industries from electronics cooling to food storage and transportation. Three other students obtained a PhD in 2018 and 2019. One of these is a senior scientist in the Navy Nuclear Laboratory, one is planning to enter academia, and one is seeking positions at national laboratories. I expect three additional students to obtain PhDs this year. The Dean of CEC wrote in his recommendation for tenure “The fact that you have produced four PhD and three MS students under your supervision while at S&T is truly exceptional.”

**DESCRIPTION OF RESEARCH**

*Multiphase Flow Experiments and Modeling*

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 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 relevant 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

I have established the Thermal Hydraulics Experiment, Modeling, and Engineering Simulation (THEMES) Laboratory at Missouri S&T, highlighted in Fig. 2. 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 and 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.

Figure 2: THEMES Laboratory

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. 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. To provide these measurements I have been working with collaborators to develop a multiple-sensor electrical resistivity probe, shown in Fig. 5, which is able to measure the droplet fraction. The probe will be used to collect extensive data under annular flow conditions to assist in code validation.

![Figure 3](image)

**Figure 3:** (a) Droplet-capable void probe; (b) continuous liquid signal; (c) droplet signal

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. 4. 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).
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;
- 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.

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 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. 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. I also developed a new interfacial area concentration correlation by deriving the Sauter mean diameter of both small, spherical bubbles and large Taylor bubbles 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 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. 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 and comparing 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.

*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**. I hope to design PCM systems that can be incorporated into the emergency core cooling systems of modern reactor systems such as 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, reducing the containment pressure and temperature. This allows smaller containment and reduced construction costs.

I began this work by investigating room-temperature PCMs. While this is a first step in a larger research program, it also has important potential impacts. The use of PCMs can reduce energy consumption in heating and cooling by 30% to 50%, **reducing energy costs and greenhouse gas emissions**. 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 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 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%. 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.

Recent research on this subject has focused on the ability of these materials to resist radiation damage during use. Two different PCMs were exposed to radiation using the Missouri S&T Reactor (MSTR) and the Missouri University Research Reactor (MURR). The melting temperature and latent heat of the samples were measured before and after irradiation in order to evaluate the potential lifetime of the materials in a radiation environment. The measurements
found no significant change in these properties at radiation doses up to 2800 Gy, representing just under one year in a nuclear reactor containment or the approximate duration of a manned journey to Mars.

Steam Condensation for Reactor Safety Applications

I was 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 experiment will be compared with CFD predictions generated using STAR-CCM+. It was observed that the software predicts the general trends of temperature distribution at various axial and radial locations. However errors in the prediction of heat transfer coefficient were significant, as they ranged from 68% near the inlet to 38%. 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.
TEACHING AND MENTORING

TEACHING STATEMENT

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.

In each of my courses, I have a few basic goals:

1. Help students accept responsibility for their own learning and develop a passion for discovery.
2. Teach students to think through problems logically and be able to explain their process.
3. Make sure students understand the basic physical principles behind key equations and concepts and relate those concepts to their real-world experience.
4. Guide students to realize how the concepts they learn in their various classes are integrated in real processes

I use several strategies to continuously improve my teaching:

• Designing varied active learning activities to appeal to different learning strategies, including in-class lectures, short on-line video lectures, and small-group problem solving activities
  o Implementing team-based learning to improve engagement and shift from large-classroom to a small-group teaching environment: encouraging peer accountability with a peer evaluation process and providing more focused ‘mini-lectures’ addressing specific concerns of individual student teams
  o Using real-world examples from research and industry, and allowing student teams to come up with their own solution to open-ended or forward-looking questions.
  o Encourage appropriate use of information technology in the classroom – for instance, using smartphones to access course materials on Canvas or look up outside data needed to solve problems.

• Use my experience in theater (I have volunteered extensively as a Master Electrician and Lighting Designer for theatrical productions) to refine classroom presentation skills – vocal inflection, control of body language, use of humor and stories to accentuate classroom material and communicate excitement for the subject.
  o Be humble and honest, willing to accept constructive criticisms. Sometimes the ability to accept and understand your own mistakes can help students connect with you.

• Informal mid-semester feedback following each exam – what worked, what didn’t, and
what should I be doing?

- Set high – but realistic – expectations. I have found that once the students understand what those expectations are many of them rise to the challenge. Treating them like adults allows them to treat themselves like adults and take the responsibility for their performance on themselves.

This approach can be seen in the student comments in Appendix C, such as “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,” “The course structure is one of the best on this campus,” and “Very tough, made me push hard to earn a grade.” The Dean of CEC observed “I am impressed by the quality and volume of your teaching, which shows true dedication to students and colleagues alike.”

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.

TEACHING RESPONSIBILITIES

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) or Probabilistic Risk Assessment (NUC ENG 4281/5281). For several years I also taught Nuclear Systems Design I (NUC ENG 4496). The syllabi for these courses can be found in Appendix B. My overall effectiveness scores for these courses, grouped into Junior level courses, Senior level courses, and Graduate level courses, can be found in Figure 8. My scores for Senior and Graduate level courses have remained high, above 3.0 since my second semester at Missouri S&T and most recently 4.0. My scores in Junior level courses have varied. The low scores for Junior level required courses during Spring 2016 and 2017 occurred when I switched courses from a traditional lecture to a small-group, team-based design. This was a difficult transition for me and for the students, however each class suggested improvements. Implementing those improvements, as well as further course development, has increased my effectiveness in those courses as shown by recent improvements. I plan to continue developing and improving the courses over the next few years.
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.

Since arriving at Missouri S&T I have worked to target my service activities to those I believe will have an impact. 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 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 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 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.

I requested to be assigned to the search committee for the Mining and Nuclear Engineering Department Chair in 2017. 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 also requested to be on the search committee for the Nuclear Engineering and Radiation Sciences department chair, which is currently ongoing.

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 21 professional journals related to nuclear engineering and multiphase flow. Over the last two years I have completed 25 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.
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. 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 lit 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 Gear City 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 Cincinnati, 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. 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. I also acted as security for various events during the convention. 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.
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APPENDIX A – CURRICULUM VITAE

Joshua Paul Schlegel
Associate Professor

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Missouri University of Science and Technology
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https://www.linkedin.com/in/schlegeljp
https://www.researchgate.net/profile/Joshua_Schlegel
https://scholar.google.com/citations?user=mhpWWK8AAAAJ&hl=en

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Phone: 573.341.7703
Fax: 573.341.6309
Email: schlegelj@mst.edu

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
Associate Professor, Undergraduate Coordinator, Department of Mining and Nuclear Engineering, Missouri S&T (March 2014 – Present)
  • Educating the next generation of nuclear scientists and engineers
    o Earned overall effectiveness of 3.6/4.0 in junior-level required courses and 4.0/4.0 in senior and graduate level elective courses
    o Advised four PhD graduates and three MS graduates, with six additional advisees currently pursuing PhD degrees and two pursuing MS degrees
  • Researching solutions to thermal-hydraulics challenges
    o Established Thermal Hydraulics Experiment, Modeling, and Engineering Simulation (THEMES) Laboratory at Missouri S&T
    o Obtained $855,000 in funding over five years.
    o Published 37 papers in peer-reviewed journals with h-index of 17
    o Awarded Young Member Achievement Award by Atomic Energy Society of Japan
  • Ensuring excellence in the undergraduate program
    o Appointed Undergraduate Coordinator after three years
    o Prepared a comprehensive undergraduate handbook for Nuclear Engineering
    o Extensive recruiting and curriculum development efforts
    o Overhauled ABET data reporting for Nuclear Engineering

OTHER PROFESSIONAL EXPERIENCE
Consultant
  • Thomas Edison State University – College equivalency review for Reactor Operator and Senior Reactor Operator licenses
  • Thomas Edison State University – College equivalency review for INPO training for non-licensed operators and radiation protection technicians
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; significant improvement in reports was noted by external research sponsors
- 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

RESEARCH

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

M.S. Thesis

Books and Book Chapters

Peer-Reviewed Journals

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


¹ Research advisee or co-advisee
² New journal, does not yet have an impact factor
³ CiteScore, Impact factor not available for this journal


Invited Presentations


Conference Proceedings (Peer-Reviewed)


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GRANTS AND CONTRACTS RECEIVED
Computational Fluid Dynamics for Fusion Component Cooling
PI: Prof. Joshua Schlegel
J.P. Schlegel

Period: August 15, 2020 – December 31, 2020
Total Budget: $11,680 (US DOE)

Undergraduate Scholarships in Nuclear Engineering at Missouri S&T (2019-2021)
  PI: Prof. Joshua Schlegel (60%), co-PI: Prof. Hyoong-Koo Lee, Prof. Carlos H. Castano
  Period: August 1, 2018 – July 31, 2020
  Total Budget: $200,000 (US NRC)
  Contribution: Primarily responsible for preparing proposal and reports; chair selection committee.

Graduate Fellowships in Nuclear Engineering at Missouri S&T 2019-2024
  PI: Prof. Ayodeji Alajo, co-PI: Prof. Joseph Graham, Prof. Joshua P. Schlegel (30%)
  Period: August 1, 2018 – June 29, 2024
  Total Budget: $400,000 (US NRC)
  Contribution: Serve on selection committee; assist with preparation of reports

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

Radiation Response of Phase Change Materials for Space and Nuclear Applications
  PI: Prof. 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. Hyoong-Koo Lee, co-PI: Prof. Joshua Schlegel
  Period: August 1, 2017 – July 31, 2019
  Total Budget: $200,000 (US NRC)
  Contribution: Assist with preparation of proposal and reports. Serve on selection committee.

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
J.P. Schlegel

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. Shaoib 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, 2018  
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

**Code Development for the Prediction of Bubble Coalescence and Breakup Rates in the Churn-Turbulent Flow Regime**  
PI: Prof. Takashi Hibiki, Purdue University (25%); Co-PI: Dr. Joshua P. Schlegel (50%), Co-PI: Prof. Mamoru Ishii (25%)  
Project Period: April 1, 2013 – December 31, 2013  
Total Budget: $100,000 (Chevron Energy Technology Company)  
Contribution: Developed MATLAB code, performed preliminary computational analysis and prepared final technical reports

**Additional Proposals Submitted**

**Using Computational and Analytical Methods to Optimize High Heat Flux Component Thermal Performance in Magnetic Confinement Fusion Reactors**  
PI: Dr. Joshua P. Schlegel  
Project Period: January 1, 2021 – December 31, 2021  
Total Budget: $99,732  
Status: Pending

**Oxygen Ingress in High Temperature Gas Reactors**  
PI: Dr. Joshua P. Schlegel, co-PI: Dr. Shaoib Usman, Dr. Muthanna Al-Dahhan  
Project Period: October 1, 2019 – September 30, 2022  
Total Budget: $800,000 (Department of Energy)  
Status: Not Funded

**Nanosurface Etched Wire-Wrapped Heat Exchanger**  
PI: Dr. Joshua P. Schlegel, co-PI: Dr. Joseph Smith  
Project Period: October 1, 2019 – September 30, 2022  
Total Budget: $800,000 (Department of Energy)
Status: Not Funded

**Sustainable Building with EMPaLA-G-doped Eco-SCC**
PI: Dr. Joshua P. Schlegel, co-PI: Dr. Kamal Khayat, Dr. Weina Meng
Project Period: September 1, 2019 – August 31, 2022
Total Budget: $306,118
Status: Not Funded

**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

**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

**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

**Quantitative Analysis of Xenon Bubble Behavior in Liquid Sodium using Digital X-Ray Fluoroscopy**
PI: Dr. Joshua Schlegel (45%); Co-PI: Dr. Hyoung-Koo Lee (45%), Dr. Fateme Rezaei (10%)
Project Period: October 1, 2018 – September 30, 2021
Total Budget: $800,000 (Department of Energy)
Status: Not Funded

**Evaluating Suitability of Phase Change Materials for Passive Nuclear Reactor Safety**
PI: Dr. Joshua Schlegel; co-PI: Dr. 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)
Status: Not Funded

**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. Shahrokhi, 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  
**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

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**GRADUATE STUDENT SUPERVISION**

**Ph.D. Degrees Completed:**

<table>
<thead>
<tr>
<th>Date</th>
<th>Student</th>
<th>Thesis/Dissertation Title</th>
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<td>August 2019</td>
<td>Hayder Al-Naseri(^5,6)</td>
<td>Bubble Dynamic Properties in Low Height Bubble and Slurry Bubble Column with Internals for Fischer-Tropsch Synthesis</td>
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<tr>
<td>May 2019</td>
<td>Hiralkumar Patel(^6)</td>
<td>Experimental Investigation of Liquid Contact in the Developing Post-Dryout CHF Flow Boiling Regime Using Surface Mounted Thermistors</td>
<td>Research Scientist, Naval Nuclear Laboratory</td>
</tr>
<tr>
<td>August 2018</td>
<td>Chandler Mills</td>
<td>Measurement of Interfacial Area</td>
<td></td>
</tr>
</tbody>
</table>

\(^5\) Student in Chemical Engineering  
\(^6\) Co-advisee
M.S. Degrees Completed:

<table>
<thead>
<tr>
<th>Date</th>
<th>Student</th>
<th>Thesis/Dissertation Title</th>
<th>Current Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2017</td>
<td>Varun Kalra</td>
<td>CFD Validation and Scaling of Condensation Heat Transfer</td>
<td>Research Scientist</td>
</tr>
<tr>
<td></td>
<td>Raymond Fanning</td>
<td>W-SMR Passive Safety Natural Convection Heat Exchanger</td>
<td>Idaho National Laboratory</td>
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<tr>
<td>May 2016</td>
<td>Rami Saeed</td>
<td>Thermal Characterization of Phase Change Materials for Thermal Energy Storage</td>
<td>Senior Energy Scientist</td>
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</tbody>
</table>

Degrees in Progress

<table>
<thead>
<tr>
<th>Degree</th>
<th>Student</th>
<th>Thesis/Dissertation Topic</th>
</tr>
</thead>
<tbody>
<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>William McCauley</td>
<td>Sensitivity of Numerical Modeling of Multiphase Heat Transfer to Constitutive Models</td>
</tr>
<tr>
<td>Ph.D.</td>
<td>Ryan Steere</td>
<td>Radiation Effects on Phase Change Material Performance</td>
</tr>
<tr>
<td>Ph.D.</td>
<td>Song Je Hong</td>
<td>Validation of CFD Models for Interfacial Area Transport in Large Diameter Channels</td>
</tr>
<tr>
<td>Ph.D.</td>
<td>Alexander Swearingen</td>
<td>Sensitivity of Numerical Modeling of Multiphase Hydrodynamics to Constitutive Models</td>
</tr>
<tr>
<td>Ph.D.</td>
<td>Monica Gehrig</td>
<td>Fusion Component Cooling Optimization Using CFD Tools</td>
</tr>
<tr>
<td>M.S</td>
<td>Murat Tuter</td>
<td>Severe Accident Analysis Using ATHLET-CD</td>
</tr>
<tr>
<td>M.S.</td>
<td>Jacob Ford</td>
<td>--</td>
</tr>
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TEACHING

COURSES DEVELOPED AND TAUGHT

Undergraduate Courses

<table>
<thead>
<tr>
<th>Year Developed</th>
<th>Course Number and Title</th>
<th>Taught</th>
<th>Overall Effectiveness (4.0 scale)</th>
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</thead>
<tbody>
<tr>
<td>--</td>
<td>NE 3221: Reactor Fluid Mechanics</td>
<td>Fall 2015 - Present</td>
<td>3.58</td>
</tr>
<tr>
<td>--</td>
<td>NE 3223: Reactor Heat Transfer</td>
<td>Spring 2016 - Present</td>
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<tr>
<td>2015</td>
<td>NE 4257: Two-Phase flow in Energy Systems</td>
<td>Spring 2015 - Present</td>
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<tr>
<td>2019</td>
<td>NE 4281: Probabilistic Risk Assessment</td>
<td>Fall 2019 - Present</td>
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<tr>
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<td>NE 4496: Nuclear Systems Design I</td>
<td>Fall 2015-Fall 2019</td>
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Graduate Courses

<table>
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<th>Overall Effectiveness (4.0 scale)</th>
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<tr>
<td>2015</td>
<td>NE 5257: Introduction to Nuclear Thermal-Hydraulics</td>
<td>Fall 2015 - Present</td>
<td>4.00</td>
</tr>
<tr>
<td>2019</td>
<td>NE 5281: Probabilistic Risk Assessment I</td>
<td>Fall 2019 - Present</td>
<td>3.33</td>
</tr>
<tr>
<td>2016</td>
<td>NE 6257: Advanced Nuclear Thermal-Hydraulics</td>
<td>Fall 2014 - Present</td>
<td>4.00</td>
</tr>
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</table>

SERVICE

PROFESSIONAL SOCIETIES

American Nuclear Society, 2005-Present

7 Most recent evaluation only
J.P. Schlegel

Thermal Hydraulics Division, 2014 – Present
Purdue University Student Chapter, 2005-2012
Outreach Committee Member, 2009-2011
Graduate Representative, 2009-2011

Thermal Hydraulics Division

AWARDS AND HONORS
Young Member Achievement Award, Thermal Hydraulics Division, Atomic Energy Society of Japan, 2017
Eagle Scout, Boy Scouts of America, 2001

PROFESSIONAL SERVICE

International Service
Reviewer

Journal of Energy Research, Journal of Nuclear Science and Technology, Nuclear Engineering and Design,
Nuclear Science and Engineering, Sensors, The Open Chemical Engineering Journal, Processes, Progress in
Nuclear Energy.

18th International Topical Meeting on Nuclear Reactor Thermal Hydraulics (NURETH-18)
August 18-23, 2019
Reviewer

27th International Conference on Nuclear Engineering (ICONE 27)
May 19-24, 2019
Reviewer

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
Women in Nuclear Advisor, 2019 – Present
CERTI Advisory Committee, 2016

Resources subcommittee - Deliberate on resources that CERTI could provide that would enhance the teaching
mission of the university, deliver recommendations to CERTI

Discipline Specific Curriculum Committee, 2019-Present
Engagement and Outreach Committee, 2020-Present
Doshi Professor of Chemical and Biochemical Engineering search committee, 2021

Department of Mining and Nuclear Engineering
Undergraduate Coordinator, 2017 – Present
Nuclear Engineering NRC Scholarship Committee, 2014 – Present
Mining and Nuclear Engineering Chair Search Committee, 2015-2016
Nuclear Engineering and Radiation Science Chair Search Committee, 2020-2021

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
Gear City 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
Sheboygan Theater Company; Sheboygan, WI, 2001-2004
   Master Electrician
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APPENDIX B – COURSE SYLLABI

REACTOR FLUID MECHANICS
NUC ENG 3221

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

Please allow up to 24 hours for a response to emails. Do not expect immediate replies, especially outside of regular business hours

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:
At the end of this course, students should be able to:
1. Translate a problem statement into a mathematical model: identify given information and problem objectives, and obtain additional data necessary to solve the problem from material property databases or other sources.
2. Recall and apply key balance equations (conservation of mass, linear momentum, and first law of thermodynamics), rate equations (i.e. Newton’s law of viscosity, head loss), and assumptions (steady state, incompressible, inviscid, etc.) to the problem.
3. Calculate pressure drop, hydraulic power, drag force, velocity, or other quantities of interest for problems in laminar flow analysis, hydrostatics, potential flows, head loss, fluid system design, and pump sizing.
4. Evaluate your solution and clearly communicate your work and its significance by analyzing the appropriateness of your assumptions and relating the problem to real-world experience, information from other fields, etc.
5. Make positive contributions to team problem-solving activities by actively (and respectfully) participating in team discussions, acknowledging the contributions of other team members, and knowing when to lead and when to follow during team activities.

What will students get out of this class?
- Improved critical thinking
- 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 judgment’ regarding real-world applications (especially nuclear reactor behavior/analysis)
- Excitement about engineering problems
- Improved ability to work on project teams

PREREQUISITES:
Students are expected to bring certain knowledge from previous courses into this course. The most important of these skills include, but are not limited to:
- Ability to solve differential equations
- Knowledge of basic physics
  - Conservation of mass
- Newton’s Second Law
- Conservation of energy
- Ability to use a computer
  - Excel, MATLAB
- Ability to draw free body diagrams
- Ability to compute forces and moments (torques)

Students who cannot accomplish these tasks should review their notes from previous courses, because detailed instructions on these topics will not be included as part of this course.

**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. This grading system is designed to reward both individual effort and group effort, as well as consistency throughout the semester (i.e. one bad exam or one good exam won’t be enough to significantly change your final grade).

**Table 1: Final Grade Assignments**

<table>
<thead>
<tr>
<th></th>
<th>Estimated Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent Performance in the Class</td>
<td>A 90-100</td>
</tr>
<tr>
<td>Good Performance in the Class</td>
<td>B 80-90</td>
</tr>
<tr>
<td>Acceptable Performance in the Class</td>
<td>C 70-80</td>
</tr>
<tr>
<td>Poor Performance in the Class</td>
<td>D 60-70</td>
</tr>
<tr>
<td>Failed to Meet the Minimum Class Requirement</td>
<td>F 0-60</td>
</tr>
</tbody>
</table>

**Table 2: Grade Categories**

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Work</td>
<td>50.0%</td>
</tr>
<tr>
<td>Homework Assignments (10)</td>
<td>50.0%</td>
</tr>
<tr>
<td>Individual Exams (5)</td>
<td>50.0%</td>
</tr>
<tr>
<td>Team Work</td>
<td>50.0%</td>
</tr>
<tr>
<td>Challenge Problems (done in class)</td>
<td>50.0%</td>
</tr>
<tr>
<td>Team Exams (5)</td>
<td>50.0%</td>
</tr>
</tbody>
</table>

**ASSESSMENTS:**

- Challenge problems will be solved in class in teams
- This will be followed by in-class discussion of the solutions
- Challenge problems will be turned in; one random problem each day will be graded according to the rubric in Table 3 (Except for Criterion 1: Formatting, which will not be included).
- If your team was marked incorrect on a challenge problem, you have the opportunity to appeal your answer to the instructor. Submit a short (1 paragraph or so) explanation of why you think your solution is correct, justified by material from the textbook and/or relevant calculations. Successful appeals will gain 1 point for
your team in the class competition, an additional 2 points of extra credit for your grade on that day’s problem set.

Homework will be turned in at the beginning of class on the day it is due.
- Homework will be an individual grade.
- Each module will have two homework assignments. The first will cover key concepts and ideas using relatively simple problems. The second will consist of more complex problems.
- The entire assignment will be graded according to the rubric in Table 3, based on your average performance in each category on the problems in that assignment.
- Late homework will not be accepted, except in case of extenuating circumstances

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.
- Problems will be graded based on the rubric provided on the Canvas course page.

Exams:
- Exams will consist of three worked-out analysis problems. You must choose two of the problems to complete
- Each problem will be graded according to the rubric in Table 3 (Except for Criterion 1: Formatting, which will not be included).
- The individual exam will require 30 minutes. This will be followed by a 20 minute team exam. The team exam will be identical to the individual exam.
- Exams will be open-notes and open-book. It is recommended that you bring a copy of the course equation sheet, available on Canvas.
- Bring a calculator to the exams.

Peer evaluations will be performed to evaluate each individual’s contribution to their group’s success. The peer evaluation criteria will be determined by the students on each team. Details are included later in the syllabus. Peer evaluations will be performed following Module 2 and Module 5.
- Each student assigns a total of 100 points, divided among the other members of the team. Do not assign yourself any points
- Peer evaluations will serve as a multiplier for your team grade (if you receive over 100, your team grade will increase; if you receive below 100, your team grade will decrease)
- The peer evaluation form is available on Canvas.

Additional extra credit will not be awarded in this class. A sample Excel spreadsheet for calculating your course grade as well as sample rubrics can be found in the ‘Additional Information’ page in Canvas.

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 and your team members 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.
### Table 3: Rubric for homework problems

#### Homework Rubric

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Acceptable</th>
<th>Poor</th>
<th>Unacceptable</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Formatting</td>
<td>Name, class number, assignment, and page number are included on the header of each page. Problems are clearly separated from one another. Engineering paper or plain white paper is used, and multiple pages are stapled.</td>
<td>Name, assignment, and page number are included on the header of each page. Problems are clearly separated from one another. Ruled/loose-leaf paper has been used, and multiple pages are stapled.</td>
<td>Name, and assignment are included on the header of each page. Problems are not clearly separated from one another. Notebook paper torn from a notebook is used, and multiple pages are stapled.</td>
<td>Header is missing. Problems are not clearly separated from one another. Paper torn from a notebook is used, and pages are not stapled.</td>
<td>/5</td>
</tr>
<tr>
<td>2. Translate the problem statement</td>
<td>All given information listed; goal of problem defined; complete sketch of problem</td>
<td>Information from the problem statement is listed; sketch is acceptable but not complete</td>
<td>Some information from the problem statement is missing; goal of problem is not clearly stated; no problem sketch</td>
<td>No information from the problem statement is clearly listed</td>
<td>/5</td>
</tr>
<tr>
<td>3. Identify and apply balance equations, rate equations, assumptions, and material properties</td>
<td>Clearly identified fundamental balance equations and rate equations; assumptions clearly stated and applied; Property data clearly identified, evaluated at proper temperature</td>
<td>Fundamental balance equations are correct; assumptions are clearly stated; Property data is correct</td>
<td>Fundamental balance equations are incorrect or not clearly identified; Assumptions are not clearly stated; Property data is clearly identified, but incorrect</td>
<td>No balance equations are identified; no assumptions are identified; Property data is not provided</td>
<td>/5</td>
</tr>
<tr>
<td>4. Method</td>
<td>Clearly organized method that demonstrates sequential thinking and that can stand alone. Includes step-by-step analysis</td>
<td>Clear method that demonstrates sequential thinking, including step-by-step analysis</td>
<td>Method is not clear, but includes step-by-step analysis</td>
<td>No clear method or analysis</td>
<td>/5</td>
</tr>
<tr>
<td>5. Calculation</td>
<td>Includes correct computation, including checking units and, if necessary, verifying the applicability of assumptions or equations</td>
<td>Includes correct computation, including checking units and verifying the applicability of equations</td>
<td>Computation is not be correct or assumptions and equations are not verified</td>
<td>Computation is not correct and assumptions or equations are not verified</td>
<td>/5</td>
</tr>
<tr>
<td>6. Evaluate your solution and its significance</td>
<td>Clear evaluation of the validity of the applied assumptions; short comment on the importance of any results; comments relate solution to topics/areas outside of this class</td>
<td>Clear evaluation of validity of assumptions, but no comment on results or relation to topics outside of class</td>
<td>Poor evaluation of validity of assumptions; but no comment on results or relation to topics outside of class</td>
<td>No evaluation or comment on validity of assumptions, or comment on significance of solution</td>
<td>/30</td>
</tr>
</tbody>
</table>

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**TECHNOLOGY IN THE CLASSROOM:**
Appropriate use of technology in the classroom is encouraged, however it should not become a distraction. Please put tablets and smartphones on silent. Appropriate uses of technology include:

- Accessing documents on Canvas
Looking up fluid properties online
Using Excel or Matlab to perform calculations for a problem
Looking up additional information online that will help you solve a problem or answer a question

Inappropriate uses of technology include, but are not limited to:
- Responding to text messages
- Checking Facebook, Instagram, or Snapchat
- Etc.

Audio or video recording during lectures and review sessions is allowed. Recording is discouraged during group activities, and is not allowed during readiness assessment tests or exams.

**ACADEMIC HONESTY:**
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/academicregulations2014-2016.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 or complaints please bring them directly to the instructor. If you feel you cannot talk with the instructor, please talk to the Program Chair, Dr. Ayodeji Alajo (alajoa@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.
<table>
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<tr>
<th>Week</th>
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<th>Topic</th>
<th>Notes</th>
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<tbody>
<tr>
<td>1</td>
<td>M01</td>
<td>Lecture</td>
<td>Video Lectures 2-7; Chapter 1.1-1.6; 2.1-2.2; 3; 4;</td>
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<tr>
<td></td>
<td>M01</td>
<td>Lecture</td>
<td></td>
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<tr>
<td></td>
<td>M01</td>
<td>Challenge Problems</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>M01</td>
<td>Lecture</td>
<td></td>
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<tr>
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<td>M01</td>
<td>Lecture and Discussion</td>
<td>Homework 1 Due; Video Lectures 8-9; Chapter 5.5; 6.1-6.3;</td>
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<td>M01</td>
<td>Challenge Problems</td>
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<tr>
<td>3</td>
<td>Labor Day</td>
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<td></td>
<td>M01</td>
<td>Challenge Problems</td>
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<td></td>
<td>M01</td>
<td>Review</td>
<td>Homework 2 Due</td>
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<tr>
<td>4</td>
<td>M01</td>
<td>Lecture</td>
<td>Video Lectures 1-6; Chapter 1.7-1.8; 7.1-7.5; 7.11-7.12; 9.1-9.4</td>
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<tr>
<td></td>
<td>M02</td>
<td>Lecture</td>
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<tr>
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<td>M02</td>
<td>Challenge Problems</td>
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<tr>
<td></td>
<td>M02</td>
<td>Challenge Problems</td>
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</tr>
<tr>
<td>5</td>
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<td>Lecture and Discussion</td>
<td>Homework 3 Due; Video Lectures 7-10; Chapter 8;</td>
</tr>
<tr>
<td></td>
<td>M02</td>
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</tr>
<tr>
<td></td>
<td>M02</td>
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<td>Challenge Problems</td>
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</tr>
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<td>7</td>
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<td>Lecture</td>
<td>Video Lectures 1-2; Chapter 2.3-2.10;</td>
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<tr>
<td></td>
<td>M03</td>
<td>Lecture</td>
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<tr>
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<td>Lecture</td>
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</tr>
<tr>
<td>8</td>
<td>M03</td>
<td>Challenge Problems</td>
<td></td>
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<td>M03</td>
<td>Challenge Problems</td>
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<tr>
<td></td>
<td>M03</td>
<td>Lecture and Discussion</td>
<td>Homework 5 Due; Video Lectures 3-6; Chapter 5.1-5.4; 7.6-7.10;</td>
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<td>9</td>
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<tr>
<td></td>
<td>M03</td>
<td>Review</td>
<td>Homework 6 Due</td>
</tr>
<tr>
<td>10</td>
<td>M03</td>
<td>Lecture</td>
<td>Video Lectures 1-4,7; Chapter 11.1-11.10</td>
</tr>
<tr>
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<td>Lecture</td>
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<tr>
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<td>M04</td>
<td>Challenge Problems</td>
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<tr>
<td>11</td>
<td>M04</td>
<td>Challenge Problems</td>
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<td></td>
<td>M04</td>
<td>Challenge Problems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M04</td>
<td>Lecture and Discussion</td>
<td>Homework 7 Due; Video Lectures 5-9, Chapter 9.5-9.8; 10.1-10.4;</td>
</tr>
<tr>
<td>12</td>
<td>M04</td>
<td>Challenge Problems</td>
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<tr>
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<td>Challenge Problems</td>
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<tr>
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<td>M04</td>
<td>Review</td>
<td>Homework 8 Due</td>
</tr>
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<td>13</td>
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<td>Lecture</td>
<td>Video Lectures 1-3, 5, Chapter 10.5; 14.1-14.4, 14.6</td>
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<td>M05</td>
<td>Lecture</td>
<td></td>
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<tr>
<td>14</td>
<td>Thanksgiving</td>
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<td>Thanksgiving</td>
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<td></td>
<td>Thanksgiving</td>
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<tr>
<td>15</td>
<td>M05</td>
<td>Challenge Problems</td>
<td></td>
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<tr>
<td></td>
<td>M05</td>
<td>Challenge Problems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M05</td>
<td>Lecture and Discussion</td>
<td>Homework 9 Due; Video Lectures 4-6; Chapter 14.5, 14.7-14.8</td>
</tr>
<tr>
<td>16</td>
<td>M05</td>
<td>Challenge Problems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M05</td>
<td>Challenge Problems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M05</td>
<td>Review</td>
<td>Homework 10 Due</td>
</tr>
<tr>
<td>Finals Week</td>
<td>M05</td>
<td>Exam</td>
<td></td>
</tr>
</tbody>
</table>
COURSE STRUCTURE:
The basic idea of team-based learning is to use our valuable and limited time in class to focus on addressing areas of confusion, solidifying and expanding on basic concepts, and improving application knowledge. This is opposed to a traditional lecture class, where class time is used to impart content knowledge from the textbook or another source and students are left to develop their application knowledge on their own (see Fig. 1). This means that in a team-based learning course you (the student) are expected to develop your initial understanding of the material through your own effort (i.e. reading the text, taking notes, etc.). Then class time is used to fix the information in memory through repetition and to practice using the content to solve problems, rather than memorizing the knowledge.

Figure 1: Use of Class Time in Lecture-Based and Team-Based Learning

This class will be making extensive use of teams. Our teams will be permanent (at least for the duration of the class). Team assignments during class will be competitions and debates among the teams. This idea is important, because a team working together can accomplish significantly more than individual members working together. A team self-organizes to take advantage of its members’ strengths and shore up their weaknesses in order to move the team as a whole forward. The team activities will foster repetition, promote individual accountability, encourage students to attempt more challenging problems, and develop students’ ability to function effectively on project teams.

The course will be organized into five modules. Each module will be (roughly) structured as shown in Table 4. Students are responsible for preparing for each module by reading the assigned text, watching the lecture videos, and taking necessary notes.

Table 4: Typical Module Structure

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Class</td>
<td>Out of Class</td>
<td>In-Class</td>
</tr>
<tr>
<td>Monday</td>
<td>Exam</td>
<td>(Previous Module)</td>
</tr>
<tr>
<td>Wednesday</td>
<td>Lecture</td>
<td>Read/Review</td>
</tr>
<tr>
<td>Friday</td>
<td>Lecture</td>
<td>Read/Review</td>
</tr>
</tbody>
</table>

In-Class Team Problems
Much of our in-class time will be spent working problems in teams. Teams will use the content from the text to answer progressively more complex problems. Typically these problems will require the team to make a decision or select from among several options. They will be open-book, and the team’s final answer will be reported on their problem sheet.

At the end of each session the teams will reveal their answers to the class. Any disagreements between the various teams will be addressed through inter-team discussions — thus the teams should be prepared to defend their decision!

The final group activity of each module in the course will be a content review. Students will be provided 5 minutes to review the content individually and identify areas that they are still struggling with. Then the teams will meet for 10
minutes to discuss those areas. During this time, teams should work on explaining these difficult concepts to each other. At the end of the 15 minutes, each team will be allowed to ask the instructor questions.

Peer Evaluations
In the peer evaluation process, each student will be allowed 100 points to assign to each of the other team members. Points should be assigned based on the degree to which each student fulfilled the criteria determined earlier in the class. The average score for each team will be 100 points. This represents average effort/effectiveness as a team member. Each team member will have their grade for group work modified by a factor $a = \frac{\text{Peer evaluation score}}{100}$. That means a team member who obtains 110 peer evaluation points will be awarded a group score of 10% higher than the actual group score. Conversely a team member with 90 peer review points will be awarded a group score 10% lower than the actual group score. An example of this process is shown in Figs. 3 and 4.

Please note that thoughtful responses on peer evaluations are necessary to keep individuals accountable for their contribution to your teams. Simply assigning everyone an ‘average’ score will hurt team members who contributed most and reward team members who do not contribute! Also note that failing to turn in your peer evaluation will result in your team members having an average score of approximately 80 points, drastically reducing their group work scores and final grades in the course!

A mid-term peer review will be performed at the end of the second course module. This mid-semester feedback will allow students to see whether they are being effective team members, and allow teammates to provide them with constructive criticisms to enable them to be more productive team participants. It will be worth 25% of the total peer evaluation grade. The final peer review will take place during the last week of the semester and will be worth 75% of the total peer evaluation grade.
Student's Name: Carolyn

<table>
<thead>
<tr>
<th>I. Graded Work: Individual Items</th>
<th>Points Earned</th>
<th>Total Points Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Individual activity, #1</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>B. Individual activity, #2</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>C. RATs: Individual Portion</td>
<td>21</td>
<td>25</td>
</tr>
<tr>
<td>D. Term Paper</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>E. Final Exam</td>
<td>26</td>
<td>30</td>
</tr>
<tr>
<td><strong>SUB-TOTAL &quot;Individual Score&quot;</strong></td>
<td><strong>86</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II. Graded Work: Group Items</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Readiness Assurance, Tests: Group Portion</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>B. Mid-Semester Application Project</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>C. Final Group Project</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td><strong>Initial &quot;Group Score&quot;</strong></td>
<td><strong>45</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>

**Adjustment for Peer Evaluation:**

- Initial Group Score: 45
- Carolyn’s Peer Evaluation Score (from Table B.2): 110%
- Adjusted Group Score (45 x 110%): 49.5

**Calculation of Carolyn’s Course Grade Points**

| I. Individual Score | 86.0 |
| II. Adjusted Group Score: | 49.5 |
| **TOTAL**          | **135.5** |
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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 the 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. Your student account will be charged for the cost of the digital course materials. If you choose to opt out of the digital content, you have until 11:59 p.m. CST Feb 5, 2019 to opt out and receive a refund. You will receive a welcome email from The S&T Store, so please watch your inbox. The AutoAccess welcome email will provide the course, charge amounts, the opt-out deadline and process. If you have any questions please contact The S&T Store via phone at 573-341-4705 or email at autoaccess@mst.edu.

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:
At the end of this course, students should be able to:
1. Translate a problem statement into a mathematical model: identify given information and problem objectives, and obtain additional data necessary to solve the problem from material property databases or other sources.
2. Recall and apply key balance equations (conservation of mass, first law of thermodynamics, etc.), rate equations (Fourier’s Law of Conduction, Newton’s Law of Cooling, Stefan-Boltzmann Law, etc.), and assumptions (steady state, uniform properties, etc.) to the problem.
3. Calculate temperatures, heat transfer rates, or other quantities of interest for problems in conduction, convection, radiation, heat exchanger analysis, and heat transfer system design.
4. Evaluate your solution by analyzing the appropriateness of your assumptions and relating the problem to real-world experience, information from other fields, etc., then make engineering decisions based on your calculations.
5. Make positive contributions to team problem-solving activities by actively (and respectfully) participating in team discussions, acknowledging the contributions of other team members, and knowing when to lead and when to follow during team activities.

What will students get out of this class?
- Improved critical thinking
- Ability to translate real-world problems into engineering models
- Ability to solve various kinds of heat transfer problems (even those they have not 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

PREREQUISITES:
Students are expected to bring certain knowledge from previous courses into this course. The most important of these skills include, but are not limited to:
- Ability to solve differential equations
Knowledge of basic physics
- Conservation of mass
- Newton’s Second Law
- Conservation of energy

Knowledge of fluid mechanics
- Finding material properties
- Solutions to the Navier-Stokes equations

Ability to use a computer
- Excel, MATLAB

Ability to draw free body diagrams

Students who cannot accomplish these tasks should review their notes from previous courses, because detailed instructions on these topics will not be included as part of this course.

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. This grading system is designed to reward both individual effort and group effort, as well as consistency throughout the semester (i.e. one bad exam or one good exam won’t be enough to significantly change your final grade).

<table>
<thead>
<tr>
<th>Table 1: Final Grade Assignments</th>
<th>Estimated Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent Performance in the Class</td>
<td>A 90-100</td>
</tr>
<tr>
<td>Good Performance in the Class</td>
<td>B 80-90</td>
</tr>
<tr>
<td>Acceptable Performance in the Class</td>
<td>C 70-80</td>
</tr>
<tr>
<td>Poor Performance in the Class</td>
<td>D 60-70</td>
</tr>
<tr>
<td>Failed to Meet the Minimum Class Requirement</td>
<td>F 0-60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2: Grade Categories</th>
<th>Subcategory Weight</th>
<th>Category Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Work</td>
<td>50.0%</td>
<td>50.0%</td>
</tr>
<tr>
<td>Homework Assignments (10)</td>
<td>50.0%</td>
<td></td>
</tr>
<tr>
<td>Individual Exams (5)</td>
<td>50.0%</td>
<td></td>
</tr>
<tr>
<td>Team Work</td>
<td>50.0%</td>
<td></td>
</tr>
<tr>
<td>Challenge Problems (done in class)</td>
<td>50.0%</td>
<td></td>
</tr>
<tr>
<td>Team Exams (5)</td>
<td>50.0%</td>
<td></td>
</tr>
</tbody>
</table>

ASSESSMENTS:
Challenge Problems
- Challenge problems will be solved in class in teams
- This will be followed by in-class discussion of the solutions
- Challenge problems will be turned in; one random problem each day will be graded according to the rubric in Table 3 (Except for Criterion 1: Formatting, which will not be included).
If your team was marked incorrect on a challenge problem, you have the opportunity to appeal your answer to the instructor. Submit a short (1 paragraph or so) explanation of why you think your solution is correct, justified by material from the textbook and/or relevant calculations. Successful appeals will gain 1 point for your team in the class competition, an additional 2 points of extra credit for your grade on that day’s problem set.

Homework will be turned in at the beginning of class on the day it is due.

- Homework will be an individual grade.
- Each module will have two homework assignments. The first will cover key concepts and ideas using relatively simple problems. The second will consist of more complex problems.
- The entire assignment will be graded according to the rubric in Table 3, based on your average performance in each category on the problems in that assignment.
- Late homework will not be accepted, except in case of extenuating circumstances

**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.
- Problems will be graded based on the rubric provided on the Canvas course page.

**Exams:**

- Exams will consist of three worked-out analysis problems. You must choose two of the problems to complete.
- Each problem will be graded according to the rubric in Table 3 (Except for Criterion 1: Formatting, which will not be included).
- The individual exam will require 30 minutes. This will be followed by a 20 minute team exam. The team exam will be identical to the individual exam.
- Exams will be open-notes and open-book. It is recommended that you bring a copy of the course equation sheet, available on Canvas.
- Bring a calculator to the exams.

Peer evaluations will be performed to evaluate each individual’s contribution to their group’s success. The peer evaluation criteria will be determined by the students on each team. Details are included later in the syllabus. Peer evaluations will be performed following Module 2 and Module 5.

- Each student assigns a total of 100 points, divided among the other members of the team. Do not assign yourself any points
- Peer evaluations will serve as a multiplier for your team grade (if you receive over 100, your team grade will increase; if you receive below 100, your team grade will decrease)
- The peer evaluation form is available on Canvas.

Additional extra credit will not be awarded in this class. A sample Excel spreadsheet for calculating your course grade as well as sample rubrics can be found in the ‘Additional Information’ page in Canvas

**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 and your team members 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.
Table 3: Rubric for homework problems
### Homework Rubric

<table>
<thead>
<tr>
<th>1. Formatting</th>
<th>Excellent</th>
<th>Acceptable</th>
<th>Poor</th>
<th>Unacceptable</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name, class number, assignment, and page number are included on the header of each page. Problems are clearly separated from one another. Engineering paper or plain white paper is used, and multiple pages are stapled.</td>
<td>Name, assignment, and page number are included on the header of each page. Problems are clearly separated from one another. Ruled/loose-leaf paper has been used, and multiple pages are stapled.</td>
<td>Name, and assignment are included on the header of each page. Problems are not clearly separated from one another. Notebook paper torn from a notebook is used, and multiple pages are stapled.</td>
<td>Header is missing. Problems are not clearly separated from one another. Paper torn from a notebook is used, and pages are not stapled.</td>
<td>/5</td>
<td></td>
</tr>
</tbody>
</table>

| 2. Translate the problem statement | All given information listed; goal of problem defined; complete sketch of problem | Information from the problem statement is listed; sketch is acceptable but not complete | Some information from the problem statement is missing; goal of problem is not clearly stated; no problem sketch | No information from the problem statement is clearly listed | /5 |

| 3. Identify and apply balance equations, rate equations, assumptions, and material properties | Clearly identified fundamental balance equations and rate equations; assumptions clearly stated and applied; Property data clearly identified, evaluated at proper temperature | Fundamental balance equations are correct; assumptions are clearly stated; Property data is correct | Fundamental balance equations are incorrect or not clearly identified; Assumptions are not clearly stated; Property data is clearly identified, but incorrect | No balance equations are identified; no assumptions are identified; Property data is not provided | /5 |

| 4. Method | Clearly organized method that demonstrates sequential thinking and that can stand alone. Includes step-by-step analysis | Clear method that demonstrates sequential thinking, including step-by-step analysis | Method is not clear, but includes step-by-step analysis | No clear method or analysis | /5 |

| 5. Calculation | Includes correct computation, including checking units and, if necessary, verifying the applicability of assumptions or equations | Includes correct computation, including checking units and verifying the applicability of equations | Computation is not be correct or assumptions and equations are not verified | Computation is not correct and assumptions or equations are not verified | /5 |

| 6. Evaluate your solution and its significance | Clear evaluation of the validity of the applied assumptions; short comment on the importance of any results; comments relate solution to topics/areas outside of this class | Clear evaluation of validity of assumptions, but no comment on results or relation to topics outside of class | Poor evaluation of validity of assumptions; but no comment on results or relation to topics outside of class | No evaluation or comment on validity of assumptions, or comment on significance of solution | /5 |

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**TECHNOLOGY IN THE CLASSROOM:**
Appropriate use of technology in the classroom is encouraged, however it should not become a distraction. Please put tablets and smartphones on silent. Appropriate uses of technology include:
- Accessing documents on Canvas
- Looking up fluid properties online
- Using Excel or Matlab to perform calculations for a problem
- Looking up additional information online that will help you solve a problem or answer a question
Inappropriate uses of technology include, but are not limited to:

- Responding to text messages
- Checking facebook, instagram, or snapchat
- Etc.

Audio or video recording during lectures and review sessions is allowed. Recording is discouraged during group activities, and is not allowed during readiness assessment tests or exams.

**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/academicregulations2014-2016.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 or complaints please bring them directly to the instructor. If you feel you cannot talk with the instructor, please talk to the Program Chair, Dr. Ayodeji Alajo (alajoa@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.
<table>
<thead>
<tr>
<th>Week</th>
<th>Class</th>
<th>Topic</th>
<th>Notes</th>
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<tbody>
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<td>1</td>
<td>Martin Luther King, Jr. Day</td>
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<tr>
<td></td>
<td>2</td>
<td>M01 Lecture</td>
<td>Video Lectures 1-6; Chapter 1, 2.1-2.3</td>
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<td>M01 Lecture</td>
<td></td>
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<tr>
<td>2</td>
<td>1</td>
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<tr>
<td></td>
<td>2</td>
<td>M01 Challenge Problems</td>
<td></td>
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<tr>
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<td>3</td>
<td>M01 Lecture</td>
<td>Homework 1 Due; Video Lectures 7-9; Chapter 3.1-3.2, 3.4</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>M01 Challenge Problems</td>
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<td>M01 Challenge Problems</td>
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<tr>
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<td>3</td>
<td>M01 Lecture</td>
<td>Homework 2 Due</td>
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<td>4</td>
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<td>M01 Exam</td>
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<tr>
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<td>2</td>
<td>M02 Lecture</td>
<td>Video Lectures 1-5; Chapter 5.1-5.7, 5.10, 6.1-6.3</td>
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<td>M02 Lecture</td>
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<td>M02 Lecture</td>
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<td>Homework 4 Due</td>
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<td>Video Lectures 1-3; Chapter 11.1-11.4, 11.7</td>
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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

RECOMMENDED TEXT BOOK(S):

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. Fundamentals of boiling phenomena will be discussed.

COURSE OBJECTIVES:
At the end of this course, students should be able to:
1. Translate a problem statement into a mathematical model: identify given information and problem objectives, identify the appropriate modeling approach and obtain additional data necessary to solve the problem from material property databases or other sources.
2. Recall and apply key balance equations (conservation of mass, linear momentum, first law of thermodynamics, etc.), rate equations (Newton’s Law of Viscosity, head loss, Fourier’s Law of Conduction, Newton’s Law of Cooling, Stefan-Boltzmann Law, etc.), and assumptions (steady state, incompressible, inviscid, uniform properties, etc.) to the problem.
3. Calculate thermodynamic efficiency, pressure drop, velocity, temperatures, heat transfer rates, void fractions, critical heat flux, or other quantities of interest for problems in power systems, laminar flow analysis, hydrostatics, potential flows, head loss, conduction, convection, radiation, heat exchanger analysis, and multiphase flow analysis.
4. Evaluate your solution by analyzing the appropriateness of your assumptions and relating the problem to real-world experience, information from other fields, etc., then make engineering decisions based on your calculations.
5. Make positive contributions to team problem-solving activities by actively (and respectfully) participating in team discussions, acknowledging the contributions of other team members, and knowing when to lead and when to follow during team activities.

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 and interpersonal 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>90-100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good Performance in the Class</td>
<td>B</td>
<td>80-90</td>
</tr>
<tr>
<td></td>
<td>Acceptable Performance in the Class</td>
<td>C</td>
<td>70-80</td>
</tr>
<tr>
<td></td>
<td>Poor Performance in the Class</td>
<td>D</td>
<td>60-70</td>
</tr>
<tr>
<td></td>
<td>Failed to Meet the Minimum Class Requirement</td>
<td>F</td>
<td>0-60</td>
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</table>

*This is a guarantee. Any student who receives above 90% will receive an A under all circumstances. However I reserve the right to curve the class (reducing the cutoff for an A to 85%, for example) when appropriate.*

Table 2: Final Grade Weighting, NE 5257

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Weight</th>
<th>Category Weight</th>
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<tbody>
<tr>
<td>Individual Work</td>
<td>70.0%</td>
<td></td>
</tr>
<tr>
<td>Homework Assignments (10)</td>
<td>60.0%</td>
<td></td>
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<tr>
<td>Final Project</td>
<td>40.0%</td>
<td></td>
</tr>
<tr>
<td>Team Work</td>
<td>30.0%</td>
<td></td>
</tr>
<tr>
<td>Challenge Problems (in class)</td>
<td>100.0%</td>
<td></td>
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Table 3: Final Grade Weighting, NE 4257

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Weight</th>
<th>Category Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Work</td>
<td></td>
<td>70.0%</td>
</tr>
<tr>
<td>Homework Assignments (10)</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Team Work</td>
<td>30.0%</td>
<td></td>
</tr>
<tr>
<td>Challenge Problems (in class)</td>
<td>100.0%</td>
<td></td>
</tr>
</tbody>
</table>

ASSESSMENTS:
Challenge Problems
- Challenge problems will be solved in class in teams
- This will be followed by in-class discussion of the solutions
- Challenge problems will be turned in; one random problem each day will be graded according to the rubric in Table 4 (Except for Criterion 1: Formatting, which will not be included).

Homework will be turned in at the beginning of class on the day it is due.
- Homework will be an individual grade.
- Each module will have two homework assignments. The first will cover key concepts and ideas using relatively simple problems. The second will consist of more complex problems.
- The entire assignment will be graded according to the rubric in Table 4, based on your average performance in each category on the problems in that assignment.
- Late homework will not be accepted, except in case of extenuating circumstances

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.
- Problems will be graded based on the rubric provided on the Canvas course page.

Peer evaluations will be performed to evaluate each individual’s contribution to their group’s success. The peer evaluation criteria will be determined by the students on each team. Details are included later in the syllabus. Peer evaluations will be performed following Module 2 and Module 5.
- Each student assigns a total of 100 points, divided among the other members of the team. Do not assign yourself any points. Do not assign fractions of points (only integers please)
- Peer evaluations will serve as a multiplier for your team grade (if you receive over 100, your team grade will increase; if you receive below 100, your team grade will decrease)
• The peer evaluation form is available on Canvas. Extra credit will not be awarded in this class. A sample Excel spreadsheet for calculating your course grade as well as sample rubrics can be found in the ‘Additional Information’ page in Canvas.

Table 4: Rubric for homework

<table>
<thead>
<tr>
<th>Table</th>
<th>Excellent</th>
<th>Acceptable</th>
<th>Poor</th>
<th>Unacceptable</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Formatting</td>
<td>Name, class number, assignment, and page number are included on the header of each page. Problems are clearly separated from one another. Engineering paper or plain white paper is used, and multiple pages are stapled.</td>
<td>Name, assignment, and page number are included on the header of each page. Problems are clearly separated from one another. Ruled/loose-leaf paper has been used, and multiple pages are stapled.</td>
<td>Name, and assignment are included on the header of each page. Problems are not clearly separated from one another. Notebook paper torn from a notebook is used, and multiple pages are stapled.</td>
<td>Header is missing. Problems are not clearly separated from one another. Paper torn from a notebook is used, and pages are not stapled.</td>
<td>/5</td>
</tr>
<tr>
<td>2. Translate the problem statement</td>
<td>All given information listed; goal of problem defined; complete sketch of problem</td>
<td>Information from the problem statement is listed; sketch is acceptable but not complete</td>
<td>Some information from the problem statement is missing; goal of problem is not clearly stated; no problem sketch</td>
<td>No information from the problem statement is clearly listed</td>
<td>/5</td>
</tr>
<tr>
<td>3. Identify and apply balance equations, rate equations, assumptions, and material properties</td>
<td>Clearly identified fundamental balance equations and rate equations; assumptions correctly stated and applied; Property data clearly identified, evaluated at proper temperature</td>
<td>Fundamental balance equations are correct; assumptions are correctly stated; Property data is correct</td>
<td>Fundamental balance equations are incorrect or not clearly identified; Assumptions are not clearly stated; Property data is clearly identified, but incorrect</td>
<td>No balance equations are identified; no assumptions are identified; Property data is not provided</td>
<td>/5</td>
</tr>
<tr>
<td>4. Method</td>
<td>Clearly organized method that demonstrates sequential thinking and that can stand alone. Includes step-by-step analysis</td>
<td>Clear method that demonstrates sequential thinking, including step-by-step analysis</td>
<td>Method is not clear, but includes step-by-step analysis</td>
<td>No clear method or analysis</td>
<td>/5</td>
</tr>
<tr>
<td>5. Calculation</td>
<td>Includes correct computation, including checking units and, if necessary, verifying the applicability of assumptions or equations</td>
<td>Includes correct computation, including checking units and verifying the applicability of equations</td>
<td>Computation is not correct or assumptions and equations are not verified</td>
<td>Computation is not correct and assumptions or equations are not verified</td>
<td>/5</td>
</tr>
<tr>
<td>6. Evaluate your solution and its significance</td>
<td>Clear evaluation of the validity of the applied assumptions; short comment on the importance of any results; comments relate solution to topics/areas outside of this class</td>
<td>Clear evaluation of validity of assumptions; but no comment on results or relation to topics outside of class</td>
<td>Poor evaluation of validity of assumptions; but no comment on results or relation to topics outside of class</td>
<td>No evaluation or comment on validity of assumptions, or comment on significance of solution</td>
<td>/5</td>
</tr>
</tbody>
</table>
RESEARCH ASSESSMENT PAPER:
Graduate students will be expected to prepare a research assessment paper on a topic within thermal-hydraulics. Undergraduate students may submit a report for extra credit equivalent to one homework assignment. The student will select a paper related to their research or interests and the content of the course. 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.
3) Prepare a short (10 minute) presentation on their analysis of the paper
   a. The presentation should focus on the significance of the paper and your evaluation/recommendations
   b. Presentations will occur during the final two days of class
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.
   a. This section should include a comparison of the selected paper with other recent work in the field as part of the evaluation
5) Analysis of the results and conclusions in the paper.
   a. This section should include a subsection detailing the lessons learned from this assignment
   b. This section should include a subsection on proposed future work that would extend the research 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)
  - 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
Each student will also prepare a short (~10 minute) presentation on their assessment. The presentation should focus on the significance of the topic and paper they selected, and on the conclusions of their analysis. A rubric for the presentation is available on Canvas.
A rough draft of the report will be due the last class day before Spring Break. This draft will be worth 25% of the project grade. A final draft will be due on Friday of finals week. This final draft will be worth 50% of the project grade. The project presentation will occur on the last class day of the semester and will be worth 25% of the project grade.

ATTENDANCE AND PARTICIPATION:
In the workplace, when someone is gone the group has to pick up the slack but the absent member still benefits from the group work. If the absent person has a good reason for being gone, explains the reason to the group, and does their best to make amends, most groups will gladly extend that benefit. If members have doubts about the reason for the absence, feel like the member is trying to freeload, or both, then the absence is likely to be a black mark what may not be forgotten when peer evaluations come around. So if you have to be absent, let your peers know in advance and make sure that you do your best to make up for it. Otherwise, you will be at risk.
If you will be absent on quiz or exam days, let the instructor know well in advance so that a makeup quiz or exam can be scheduled.

**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.

**TECHNOLOGY IN THE CLASSROOM:**
Appropriate use of technology in the classroom is encouraged, however it should not become a distraction. Please put tablets and smartphones on silent. Appropriate uses of technology include:
- Accessing documents on Canvas
- Looking up fluid properties online
- Using Excel or Matlab to perform calculations for a problem
- Looking up additional information online that will help you solve a problem or answer a question

Inappropriate uses of technology include, but are not limited to:
- Responding to text messages
- Checking facebook, instagram, or snapchat
- Etc.

Audio or video recording during lectures and review sessions is allowed. Recording is discouraged during group activities, and is not allowed during readiness assessment tests or exams.

**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.

**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 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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<td>Video Lectures; Todreas &amp; Kazimi Chapter 1 and 2</td>
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<td>SPRING RECESS</td>
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<td>Video Lectures; Todreas &amp; Kazimi 8, 10</td>
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<td>M04 Challenge Problems - Numerical Methods</td>
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<td>Video Lectures; Todreas &amp; Kazimi 5, 11</td>
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</tbody>
</table>

J.P. Schlegel
INTRODUCTION TO PROBABILISTIC RISK ANALYSIS
NUC ENG 4281/5281

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

TEXT BOOK:

COURSE DESCRIPTION:
A study of the techniques used in the nuclear power industry to quantitatively assess risk, reliability, and safety in complex systems. Students will learn about the classifications of accidents in nuclear power facilities, radiological consequences of accidents, and PRA-informed regulation of nuclear power. The course will be focused on core damage frequencies and large early release frequencies.

COURSE OBJECTIVES:
1. Describe design-basis accidents, power excursions, power/coolant mismatch, loss of coolant, and station blackout accidents and their causes and consequences.
2. Prepare fault and event trees for basic scenarios and calculate system failure probabilities (i.e. core damage frequency)
3. Interpret the results of fault and event tree analysis in terms of risk mitigation.
4. Describe the role of best-estimate analysis, the importance of uncertainty analysis, and key methods for uncertainty modeling.
5. Describe how PRA influences regulation and policy.

What will students get out of this class?
- Improved critical thinking abilities
- Ability to translate real-world problems into engineering models
- Improved understanding of the accident scenarios and challenges facing nuclear reactor facilities
- Ability to use and interpret PRA in situations important to nuclear power and other industries

PREREQUISITEST:
Students are expected to bring certain knowledge from previous courses into this course. The most important of these skills include, but are not limited to:
- Solve basic differential equations
- Understand and use principles from probability and statistics
  - Boolean algebra
  - Bayes’ Theorem
  - Basic discrete and continuous probability distributions
  - Basic characteristics of random variables
  - Chi-squared tests
  - Regression analysis

Students who cannot accomplish these tasks should review their notes from previous courses, because detailed instructions on these topics will not be included as part of this course.

GRADING POLICY:
Final grades will be assigned as detailed in Table 1. The instructor reserves the right to curve the grade distribution to reflect class performance and variations in the difficulty of exams and assignments.

Table 1: Final Grade Assignments

<table>
<thead>
<tr>
<th>Score</th>
<th>Excellent Performance in the Class</th>
<th>A</th>
<th>90-100</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Good Performance in the Class</td>
<td>B</td>
<td>80-90</td>
</tr>
<tr>
<td></td>
<td>Acceptable Performance in the Class</td>
<td>C</td>
<td>70-80</td>
</tr>
<tr>
<td></td>
<td>Poor Performance in the Class</td>
<td>D</td>
<td>60-70</td>
</tr>
<tr>
<td></td>
<td>Failed to Meet the Minimum Class Requirement</td>
<td>F</td>
<td>0-60</td>
</tr>
</tbody>
</table>

*This is a guarantee. Any student who receives above 90 will receive an A under all circumstances. However I reserve the right to curve the class (reducing the cutoff for an A to 85, for example) when appropriate.

Table 2: Final Grade Weighting

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Final Project</td>
<td>30%</td>
</tr>
<tr>
<td>Homework</td>
<td>70%</td>
</tr>
</tbody>
</table>

**PROJECT:**

- You will have a final project for this course.
- The goal of the project is to determine the optimum method for cooking a Thanksgiving turkey.
  - The minimum selection of cooking options are: the oven, an outdoor grill, and deep frying.
  - Your decision should assign value to, at minimum, flavor, cost per serving, and risk.
  - You can include additional cooking methods or decision factors.
- Each student will submit a report detailing their method, no more than 4 pages in length, on the last class day of the semester.
  - The rubric and formatting/content expectations can be found on Canvas
- Each student will prepare a poster and present their poster during the last class day of the semester.
  - The rubric and poster template can be found on Canvas
  - Some examples of previous posters and reports can be found on Canvas

**HOMEWORK:**

- Homework will be turned in at the beginning of class on the day it is due.
- Grades will be assigned based on the rubric shown in Table 3.

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.
- Problems will be graded based on the rubric provided on the Canvas course page.

Extra credit will not be awarded in this class. A sample Excel spreadsheet for calculating your course grade as well as sample rubrics can be found in the ‘Additional Information’ page in Canvas.
Table 3: Rubric for homework

### Homework Rubric

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Acceptable</th>
<th>Poor</th>
<th>Unacceptable</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Formatting</strong></td>
<td>Name, class number, assignment, and page number are included on the header of each page. Problems are clearly separated from one another. Engineering paper or plain white paper is used, and multiple pages are stapled.</td>
<td>Name, assignment, and page number are included on the header of each page. Problems are clearly separated from one another. Ruled/loose-leaf paper has been used, and multiple pages are stapled.</td>
<td>Name, and assignment are included on the header of each page. Problems are not clearly separated from one another. Notebook paper torn from a notebook is used, and multiple pages are stapled.</td>
<td>Header is missing. Problems are not clearly separated from one another. Paper torn from a notebook is used, and pages are not stapled.</td>
<td>/5</td>
</tr>
<tr>
<td><strong>2. Translate the problem statement</strong></td>
<td>All given information listed; goal of problem defined; complete sketch of problem</td>
<td>Information from the problem statement is listed; sketch is acceptable but not complete</td>
<td>Some information from the problem statement is missing; goal of problem is not clearly stated; no problem sketch</td>
<td>No information from the problem statement is clearly listed</td>
<td>/5</td>
</tr>
<tr>
<td><strong>3. Identify and apply balance equations, rate equations, assumptions, and material properties</strong></td>
<td>Clearly identified fundamental balance equations and rate equations; assumptions are clearly stated and applied; Property data is correctly identified, evaluated at proper temperature</td>
<td>Fundamental balance equations are correct; assumptions are clearly stated; Property data is correct</td>
<td>Fundamental balance equations are incorrect or not clearly identified; Assumptions are not clearly stated; Property data is clearly identified, but incorrect</td>
<td>No balance equations are identified; no assumptions are identified; Property data is not provided</td>
<td>/5</td>
</tr>
<tr>
<td><strong>4. Method</strong></td>
<td>Clearly organized method that demonstrates sequential thinking and that can stand alone. Includes step-by-step analysis</td>
<td>Clear method that demonstrates sequential thinking, including step-by-step analysis</td>
<td>Method is not clear, but includes step-by-step analysis</td>
<td>No clear method or analysis</td>
<td>/5</td>
</tr>
<tr>
<td><strong>5. Calculation</strong></td>
<td>Includes correct computation, including checking units and, if necessary, verifying the applicability of assumptions or equations</td>
<td>Includes correct computation, including checking units and verifying the applicability of equations</td>
<td>Computation is not be correct or assumptions and equations are not verified</td>
<td>Computation is not correct and assumptions or equations are not verified</td>
<td>/5</td>
</tr>
<tr>
<td><strong>6. Evaluate your solution and its significance</strong></td>
<td>Clear evaluation of the validity of the applied assumptions; short comment on the importance of any results; comments relate solution to topics/areas outside of this class</td>
<td>Clear evaluation of validity of assumptions, but no comment on results or relation to topics outside of class</td>
<td>Poor evaluation of validity of assumptions; but no comment on results or relation to topics outside of class</td>
<td>No evaluation or comment on validity of assumptions, or comment on significance of solution</td>
<td>/5</td>
</tr>
</tbody>
</table>

**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.

It is expected that you will be respectful during class periods. Please keep outside distractions to a minimum.

**TECHNOLOGY IN THE CLASSROOM:**
Appropriate use of technology in the classroom is encouraged, however it should not become a distraction. Please put tablets and smartphones on silent. Appropriate uses of technology include:

- Accessing documents on Canvas
- Looking up key data online
- Using Excel or Matlab to perform calculations for a problem
- Looking up additional information online that will help you solve a problem or answer a question

Inappropriate uses of technology include, but are not limited to:

- Responding to text messages
- Checking facebook, instagram, or snapchat
- Etc.

Audio or video recording during lectures and review sessions is allowed. Recording is discouraged during group activities, and is not allowed during quizzes or exams.

**ACADEMIC HONESTY:**
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 or complaints please bring them directly to the instructor. If you feel you cannot talk with the instructor, please talk to the Program Chair, Dr. Hyoung Koo 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 COURSE SCHEDULE:**

<table>
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<tr>
<th>Week</th>
<th>Class</th>
<th>Topic</th>
<th>Reading</th>
<th>Notes</th>
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<tr>
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<td>Chapter 1</td>
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<td>Lecture: Risk Analysis</td>
<td>Chapter 2</td>
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<td>Lecture: Risk Assessment and Management</td>
<td>Chapter 8</td>
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<td>Chapter 5</td>
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<td>Challenge Problems</td>
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<td>Lecture: Best-Estimate Simulations</td>
<td>Homework 5 Due (Failure Modeling)</td>
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<td>Lecture: Best-Estimate Simulations</td>
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<td>Lecture: Uncertainty</td>
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<td>Instructor-Led Problems</td>
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<td>3</td>
<td>Challenge Problems</td>
<td></td>
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<tr>
<td>14</td>
<td>1</td>
<td>Severe Accident Analysis</td>
<td>Homework 6 Due (Uncertainty)</td>
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<td>3</td>
<td>Radiation Transport and Consequences</td>
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<td>15</td>
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<td>Review</td>
<td>Homework 7 Due (Level 2 and 3)</td>
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<td></td>
<td>3</td>
<td>Review</td>
<td>Project Presentations</td>
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</tbody>
</table>
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ADVANCED NUCLEAR THERMAL HYDRAULICS
NUC ENG 6257

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

Please allow up to 24 hours for a response to emails. Do not expect immediate replies, especially outside of regular business hours

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
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:
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>
<thead>
<tr>
<th>Score</th>
<th>Excellent Performance in the Class</th>
<th>A</th>
<th>90-100</th>
</tr>
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<tbody>
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<td>Score</td>
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<tr>
<td>Score</td>
<td>Failed to Meet the Minimum Class Requirement</td>
<td>F</td>
<td>0-59</td>
</tr>
</tbody>
</table>

* This is a guarantee. Any student who receives above 90% will receive an A under all circumstances. However I reserve the right to curve the class (reducing the cutoff for an A to 85, for example) when appropriate.

Final grades will be the average of the 15 homework assignments due throughout the semester.

ASSESSMENTS:
Homework will be turned in at the beginning of class on the day it is due.

- Homework will be an individual grade.
- Late homework will not be accepted, except in case of extenuating circumstances

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.

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.
TECHNOLOGY IN THE CLASSROOM:
Appropriate use of technology in the classroom is encouraged, however it should not become a distraction. Please put tablets and smartphones on silent. Appropriate uses of technology include:
- Accessing documents on Canvas
- Looking up fluid properties online
- Using Excel or Matlab to perform calculations for a problem
- Looking up additional information online that will help you solve a problem or answer a question
Inappropriate uses of technology include, but are not limited to:
- Responding to text messages
- Checking facebook, instagram, or snapchat
- Etc.
Audio or video recording during lectures and review sessions is allowed. Recording is discouraged during group activities, and is not allowed during readiness assessment tests or exams.

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.

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 Department Chair, Dr. Ayodeji B. Alajo.
## TENTATIVE SCHEDULE (SUBJECT TO CHANGE):

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## 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.
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APPENDIX C – SELECTED STUDENT EVALUATION COMMENTS

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.
The group mechanic of the course was highly appreciated and it did help distribute the work and simulate a more cooperative environment.
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.
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.
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.
I would try to suggest trying to explain or compare certain concepts to everyday things more often would improve comprehension.

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

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.

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.

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

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. Continue to use teams because having other people to consult with 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.

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.
Very enthusiastic in teaching and tried to provide materials which help student understand the contents of the lecture. Those effort motivated me a lot.
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.
Is willing to take suggestions for improvement and is actively trying to improve his way of teaching.

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. 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. 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. One of the biggest strengths of this course is having design problems that work well with the team structure.

**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 3221:**
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. Runs the flipped course very well, matches his style of teaching. Sometimes his answers to questions in class would be a bit confusing. 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. Expects the ability to solve problems numerically; the skills needed for this could have been elaborated on better.

Spring 2019:

**NUC ENG 3223:**
Adapts the course to help the students learn in the best way possible. Sometimes overlooks simple concepts that was assumed known by the students. Ability to adapt to multiple learning styles. I felt that at times the course moved too quickly, and/or that more information than necessary was being presented, which made it a bit overwhelming to try to learn/retain the necessary subject matter. He does a very good job of getting students to work together. Has the most organized canvas I've seen. Something that I had in a high school class that also used video lectures which was very helpful - we had guided notes to complete along with the lectures, to make sure we pulled the most important information out of the videos. The guided notes also had a couple practice problems at the end to test if you understood the material (and it made it easy to identify areas that you needed to spend a little more time on/ask the instructor for further clarification). I think something like this would be helpful rather than just watching all the videos and trying to take notes on what seems important. A huge strength is the team aspect of the class, I have never had a class that taught me how to work so effectively with a group of people to accomplish a goal. I felt really motivated and enjoyed the course's material. It was extremely applicable in the problem sets and test questions. A little more education into CFD in class would be helpful for CFD modeling (rather than just following the tutorials) The course structure is one of the best on this campus. By applying this structure to the course you get experience working together on engineering related problems. Some like to say that they may not learn enough from it, that’s because they are the ones that sit back and let the rest of the group do the work. I found that they group work really progressed my ability to problem solve efficiently due to the time constraint of 50 minute classes in which we were expected to solve the problems. Ability to choose how to learn the material. Doing group problems in class engages students and encourages them to ask questions. Letting the class decide a grading scale allows them to put value into what they want their team to do to succeed.

**NUC ENG 4257:**
At times there is almost too much detail and material presented at once, which made it difficult to follow along. Being more concise with the material, specifically the theory - it was helpful to know some background information, but when there was a lot of theory and derivation being presented, it was hard to follow where the assumptions were being applied and how to actually apply
the material to problem solving.
I think a major weakness was that it was a small group with very different backgrounds - a mix of juniors/seniors and graduate students. The majority of the course was a review for the undergraduate students, which was helpful for its own reasons, but it kind of took away from the purpose of taking the elective to learn more about two-phase flows.

**Fall 2019:**

**NUC ENG 3221:**
The instructor wasn't very good at teaching/instructing, but offered great resources for us to figure things out.
Dr. Schlegel's major weakness I feel is the ability to put a complex subject into simple terms. He is good however, at creating independent students who learn to problem solve on their own. He releases most info in online videos instead of lectures and then will sprinkle info while we do group problems, which could make it or break it for some. He does know the info and will gladly help when asked, which makes the class feel a lot warmer than it could be.
I feel I learned more in a semester than in any other class due to the reverse classroom method. Of course this comes with the con of this class being by far the one I had to put most time into.
We got to do way more examples and see where it's applied in real life much more when compared to any other class.
Does a great job relating the material to real life scenarios
At the beginning of the semester do the example problems very formally in the way that you want problems on the homework done and explain where point are coming from because I know a lot of people lost points at the beginning trying to figure out how you wanted things formatted. Explain why you are doing what you are doing when you do the examples. Explain the selection of certain equations, their associated assumptions, and how that simplifies the equation (this is more important early in the semester). Upload the work for the examples you do in class to canvas because sometimes you would go faster than I could keep up with and then switch to the next page so I would have missing work in my notes making it hard to follow when I went back and looked at it.
Integrating and streamlining what's taught and having information required to do problems would be incredible helpful - things like what assumptions you can make, what the formulas mean and when they're used, etc.

**NUC ENG 4496:**
Dr. Schlegel does care about the students understanding of the material, and does a good job measuring our understanding with essays.
The instructor was willing to meet outside of class to discuss the project and provided valuable feedback.
Very prepared and very thorough on what he wants to see in reports. Always gives constructive feedback and is welcoming to questions.
The presentations given by the teacher are great. If there way to get more of these lectures about topics like approaches to design of projects.
In some areas there wasn't a full directions on what to expect for reports/progress presentations.
His use of technology in the classroom is absolutely fantastic. It's very clear that he spends a large amount of time preparing for all of his classes.
Dr. Schlegel is really good at communicating with the class - he always explains why the material we are covering is important, and he frequently checks in to make sure that we are understanding expectations. He also solicits our feedback on things that are going well/not going well with the course, which is really helpful. The course puts the stress of forcing underperforming students to work on the ones who are appropriately dedicated to the project. I notice that every team has people that would most likely not hurt their team if they did not do anything. Many of these people will probably still get good peer evals because nobody wants to be the executioner for their useless teammate. I would like to see less on ethics and safety and more on design considerations in the nuclear field. Some choices we made were based on things we were familiar with instead of actually comparing all relevant options.

I really enjoyed the challenge and free-form learning/research I was able to do. I felt somewhat overwhelmed at the beginning of the semester, but as our project became more defined I was able to work in a more focused fashion. I really enjoyed the weekly-ish project update presentations. The opportunity to get instant feedback from our peers and the faculty was very nice to have.

Teams should be formed at the end of the previous semester, with minor reorganization to adjust for added/dropped students.

**NUC ENG 5281:**
He wants to make sure we understand the material. He needs a little more experience with the material and book but since this is the first time the course has been taught in several years it will come with time. Dr. Schlegel is a very effective motivator and stresses the importance of any material he teaches. He acknowledges his mistakes and errors when presented with the evidence to prove them. Strongly cared about content, kept material fun and interesting Information wasn't always readily available

The major weakness I see in his instruction is that he speaks very quickly to cover all of the material, which often leads to students falling behind. Slowing down slightly allows for students to take more detailed notes and follow the lecture more closely. This would also help in-class problems as students would be able to process the information for a little longer.

The course is very good at explaining a topic that is rising more and more in the nuclear industry. None of our previous classes had this topic for us.

The statistics portion had a large portion of material which I had not seen before, so more time spent covering that would be helpful.

I hope it would help for students to understand context if there are - more calculation examples for each chapter - more visual materials that can represent context

The questions posed in the class should be re-written to make them more understandable. The course could also improve by having more examples worked out in class to better describe the process of the problem.

**Spring 2020:**
**NUC ENG 3223:**
He is very accessible for questions, especially during group work. When doing examples in class, it seems like numbers come out of nowhere with little context.
Spend more time integrating concepts directly with examples. In the current state, they feel very isolated from each other.
Work on having full and prepared lectures and try to give them from our point of view.
In class lectures could be a little more conceptual, or examples done in class could be more pertaining to questions seen on tests, homework.

**NUC ENG 4257/5257:**
Dr. Schlegel is always prepared for class -- more so than any other professor I've had at S&T. He understands his own limitations as an instructor and, instead of doing contrived examples on the board, Dr. Schlegel gives us example problems to work in teams, which is much more fun, more interesting, and more like a real engineering process.
His videos/lectures/powerpoints also move incredibly quickly, sometimes missing key notation explanations, which left me confused.
Limit the scope of some of the planned course content in order to provide more time for some difficult concepts. I also think that, since the video lectures will rarely have to be re-done, it would be reasonable to try and record some worked example problems to post as well, as another avenue for learning.
Best Canvas page for any class I’ve had.
Dr. Schlegel is the main person in this department who makes me feel that I am an engineer.

**Fall 2020:**
**NUC ENG 3223:**
The use of short instructional videos on Canvas combined with group problems in class is a great learning atmosphere.
10/10 would recommend him as a professor in the future.
The unique course structure is difficult to adjust to in the beginning.
Hard to keep track of your total grade without the use of canvas grades.
Dr. Schlegel is very receptive to comments about the course, and during the semester, several suggestions by students were implemented
Mention the importance of videos/flipped style of the course a bit earlier in the year.
While the instructor may blow past some things, all it takes is for you to ask him a question and he is more than willing to go back and explain.
Emphasize the before class videos more.
If the CFD tutorials were updated and/or expanded, I would find them increasingly useful.
I also think that the videos could use an update to remove information that the class no longer goes over.
Maybe mention how these types of problems and question are solved in the real world.
Explain more how to use Excel to solve problems in this class.

**NUC ENG 6257:**
Even if you ask him the most weird question during the class, he will never humiliate you and he will make you understand.
For students who were not able to join class that day in person and had to take class online, it was not possible to see the equations on the blackboard since we didn't have a camera on that classroom. Once you can only follow class with presentations and if you don't know what's going on the blackboard, then it is a big minus for the student.