Students should complete, electronically sign, and upload this form on Canvas. The capstone supervisor will then use Canvas to comment, and note a grade of S(atisfactory) or U(nsatisfactory). The capstone coordinator will collate and submit the S/U grades to registry. If a student’s progress is Unsatisfactory, s/he must submit a work plan for the supervisor’s approval, prior to the end of Week 2 of Semester 2. Only with this approval, may the student register for the Semester 2 capstone module. A grade of ‘IP’ will then be entered for Semester 1.

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| Capstone Project Title: Algorithmic solution of higher order partial differential equations in Julia via the Fokas transform method | |
| Student Name: Linfan XIAO | Student ID: E0004050 |
| Supervisor Name: Prof. David Smith | Major: MCS |

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| **Student Self-Assessment** |
| Which goals in your capstone proposal have been achieved thus far? Are you on track with your timeline? Which skills have you acquired or practiced? What problems, if any, have you encountered? |
| This semester has been devoted to the first goal of my capstone, which is to implement the Fokas method in Julia. The implementation is divided into two parts, namely constructing valid adjoint boundary conditions and implementing the Fokas transform pair, which occupied the first and second halves of the semester, respectively. The implementation is nearly completed, except for a last step concerning finding the zeroes of exponential polynomials, which is also required for verifying the implementation. Writing documentation for the implementation, however, will need to be pushed to the winter break. Yet the progress is on track with respect to what was planned to be completed before the second semester.  The skills I have practiced so far include technical skills such as mathematics literature review and programming, as well as soft skills such as problem-solving and project management. Opportunities to practice these skills came in the form of challenges. The first few weeks of reviewing literature have been challenging. The reading material was dense, and in trying to understand it, I found myself frequently integrating materials from different courses taken before while filling in any gaps on the spot by consulting other resources. Keeping reading notes, rewriting the proofs I encountered in my own words, and supplying my own proofs for statements in the reading turned out to be extremely helpful in digesting the material. Translating mathematics into code is another challenge I encountered. My prior experience in programming primarily involves data analysis, and I have come to realize that defining mathematical objects and operating on them requires a different way of thinking that places heavier emphasis on structure, which includes data structure as well as the dependencies of different functions or workflows. My lack of experience in this aspect has translated into picking up knowledge of data structure on the fly and creating certain structures or workflows to use without being fully aware of the consequences of my choices (despite honest attempts). I have improved over the semester by learning through trial and error and plan to reflect on it systematically when writing the documentation during winter break.  Among soft skills, problem-solving stood out as one I sharpened the most during this semester. Due to the inter-disciplinary nature of my capstone, I frequently drew inspirations from mathematics and programming and have successfully solved problems by combining the two approaches. For instance, in determining the formula for the coefficient of a certain term in a triple sum, I used a symbolic math package to obtain the coefficients for the first few cases, deduced a general formula, and then proved it. This approach was different from what my supervisor initially suggested (which is direct proof), but I have been learning to combine advice with my own ideas and strengths to come up with satisfying solutions. Besides the technicalities of problem-solving, it is also important to be able to discern a worthy approach and push on it even if there is little evidence besides one’s own judgement that it would work. At the beginning of the project, being new to the field, I was hesitant to pursue (suggest pursuing, in fact) a new idea on constructing valid adjoint boundary conditions precisely because it was new. Fortunately, with proper reassurance and encouragement from my supervisor, I managed to develop the idea into a full solution that constitutes an important part of my capstone.  A more general problem I encountered and foresee to persist is translating the analytical into the numerical. A typical manifestation of the problem would be that throughout this semester, I frequently found myself replacing the “==” sign for equality with some approximation function in the implementation. The issue reflects the fact that absolute statements in the analytical world would need to be replaced by approximations in the numerical world. Moreover, such approximations are potentially context-dependent, e.g., a tolerance level that works in one scenario may not be appropriate in another. I have taken measures to deal with such issues when they arose, but I have yet to consider how to deal with them systematically (and hopefully more efficiently than my current approach). I plan to do so when organizing the implementation as a package and writing its documentation during the winter break. |
| What goals will you tackle next semester? If you have faced challenges in Semester 1, how do you hope to overcome these in Semester 2? What academic skills do you aim to cultivate? |
| Assuming that progress is on track during the winter break, the next semester will be devoted to the second goal of my capstone, which is to build a numeric-analytic integrator tailored for the solutions of the class of partial differential equations that the Fokas method can solve. The challenges I faced in Semester 1 can be overcome by practicing, self-studying (numerical analysis), and taking relevant courses (data structures). Besides continuing practicing the skills mentioned in the last section, I aim to (should the opportunity arises) cultivate the ability to solve problems not just using given resources such as assigned readings, but also through searching for relevant literature on my own. I had some practice in this aspect in Semester 1 when looking for ways to construct valid adjoint boundary conditions, yet they did not amount to much as the problem was eventually solved using an algorithm constructed from the assigned reading. Since the second goal of my capstone requires review work such as surveying existing integrators, I hope to gain more experience in researching relevant information on my own during Semester 2. |

Student’s Signature : Linfan XIAO Date: 2018/11/23