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: Approximate expansions for wave and KdV equations in the velocity potential and non-local formulations | |
| Student Name: Sultan Aitzhan | Student ID: A0152461M |
| Supervisor Name: Katie Oliveras (SeattleU), Dave Smith (Yale-NUS) | 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? |
| So far, we have largely understood the derivation of the wave & KdV equations on the whole line, and have started tackling the half-line problem. We have tentatively derived the KdV equation on a half-line, though a careful numerical investigation should be conducted to see if the derivation makes sense. Now, we are starting to look at the non-local formulation, to understand the problem better from a different perspective. The hope is that the non-local formulation will shed light on the aspects of the problem that are not immediately discernible in the velocity potential formulation.  Timeline-wise, both the primary supervisor (PS) and the mentee have had difficult schedules during semester 1, which led to starting the work with the non-local formulation on Nov 14, 2 weeks later than planned. However, the student will travel to the US in December to work with the supervisor for around 6-7 days, to work on the non-local part. This will make up for the delay.  Several skills were improved during semester 1. One is literature review. At the start of the semester, the student was tasked with reading up on the basics of fluid dynamics. The readings were dense, and at many points, the student had to choose between going deep into the details or just accepting the intuitive description of the problem and moving on. Given the amount of material covered, it was thus important to be strategic and identify how the material should be covered. With the guidance of PS, the student was able to focus on areas that matter most. The student also practiced the skill of rewriting the material, to solidify understanding of material. This was (usually) done by rewriting the relevant statement in the student’s own language, providing a more intuitive explanation, and mentioning the relevance of a derivation or a proof. Finally, the student has improved his presentation skills, learning how to present a mathematically involved capstone to an audience largely unfamiliar with mathematics.  One challenge that we encountered at first was that of organization. Given that math problems are usually dealt with in-person, it was unclear how the student and PS were to share their notes, or do derivations during meetings. Fortunately, the student and PS possess tablets; this allowed to communicate symbolically during meetings. The main difficulty during semester 1 was having to learn on the go. Several concepts used in derivations, such as dispersion relation, and principle of maximal balance, were hard to understand without a background in relevant fields. Moreover, unfamiliarity with some equations and their properties also led to a trouble in conducting the half-line derivation. |
| 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? |
| During winter break and in semester 2, we will work on the non-local derivation of equations, and using these insights, will complete the derivation from the velocity potential formulation. Relevant numerical investigation will be undertaken to verify and justify the formal expansions.  With regards to the challenges faced, we will solve more examples, both by hand and numerically, to see how concepts of dispersion relation and maximal balance, allow one to perform an approximation procedure. Another challenge is that we should conduct a better literature review, to at least have an idea of how the KdV equation on the half-line might or might not look like. Time-wise, both the student and the primary supervisor should have lighter schedules in semester 2, which will allow to focus on the project.  In addition to working on the skills mentioned, the student will learn to come up with numerical models. In semester 2, the project will also have a computational component to it, in which the student will be introduced to various computer tools used in water waves investigation. Some of these the student will know from his classes (YSC3244 Numerical Analysis, YSC4220 OPDE), and others he will learn on his own or under the guidance of the PS. These tools will allow the student to learn to model the relevant problem numerically, which will in turn play a big role in determining the utility of new derivations. |

Student’s Signature : Sultan Aitzhan Date: Nov 18, 2019