ENGG901

Computational Engineering Methods and Applications

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Instructor Contact Details

Lecturer-in-charge: Ming LI

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Office location: Huajiachi Campus, Zhejiang University, Hangzhou, China
Consultation Time: Book appointment by sending email to: wlwyxy_29@zju.edu.cn

Teaching Times, Modes and Locations

Course Duration: 11 Jan 2026 to 30 Jan 2026
Modes: Face-to-face
Location: Huajiachi Campus, Zhejiang University via face-to-face

Academic Level

Postgraduate

Credit Points:

The course is worth 6 units of credit point.

Credit Hours

The number of credit hours of this course equals to the credits of a standard semester- long course.

Contact Hours

The course contains a total of 53 contact hours, which consists of orientation, lectures, seminars, quiz, discussion, research, case study, small tests, assignments, on-site field trip(s), in-class and after-class activities, revision, self-study, and final exam. Students will receive an official transcript which is issued by Zhejiang University when completing this course.

Enrolment Requirements

Eligibility requires enrollment in an overseas university as an undergraduate or postgraduate student, proficiency in English, and pre-approval from the student's home institution.

Course Description:

This course introduces students to advanced numerical and computational techniques for solving complex engineering problems. Students will explore modern computational architectures and develop high-performance simulation tools using compiled languages such as Fortran, with a focus on parallel computing (MPI/OpenMP), spectral methods, and advanced linear solvers including multigrid and Krylov subspace solvers. Emphasis is placed on real-world application in fluid and solid mechanics, engineering software design, and collaborative project work. Students will build confidence in designing and benchmarking their own engineering simulation tools to meet professional and academic standards.

Prerequisite:

N/A

Learning Resources

- *High Performance Computing: Modern Systems and Practices* by Thomas Sterling and Matthew Anderson, Morgan Kaufmann, 2017
- *Numerical Recipes: The Art of Scientific Computing* by William H. Press, Cambridge University Press, 2007

Learning Objectives

By the end of this course, you should be able to:

- Collaborate effectively in small groups to deliver technically complex engineering software projects.

- Understand and apply engineering standards for simulation quality and benchmarking of results.

- Design simulation software, selecting appropriate numerical methods, computational architectures, and programming languages.

- Choose and justify the most appropriate numerical tools for specific engineering problems, including problem simplification strategies.

- Apply advanced numerical techniques (e.g., multigrid solvers, Krylov solvers, spectral methods) to engineering simulations.

- Demonstrate proficiency in building efficient and robust simulation tools for engineering analysis.

Course Delivery:

- Face-to-face Lecture mode includes lectures, seminars, quiz, discussion, research, case study, small tests, assignments, on-site field trip(s), in-class and after-class activities, revision, and final exam.

The following course will be taught in English. There will also be guest speakers and optional field trips available for students who would like to enhance their learning experience. All courses and other sessions will be run during weekdays.

Topics and Course Schedule:

WK	Topic	Activities
1	Introduction to compiled languages and Fortran	Lecture; Tutorial
1	High-performance computing and basics of MPI	Lecture; Tutorial
1	Linear system solvers; MPI hands-on	Lecture; Tutorial
1	Advanced MPI and memory management	Lecture; Tutorial
1	Project planning and architecture design	Lecture; Tutorial
2	Multigrid solvers: theory & practice	Lecture; Tutorial
2	Krylov subspace solvers (CG, GMRES)	Lecture; Tutorial
2	Spectral methods I (Fourier/Chebyshev)	Lecture; Tutorial
2	Spectral methods II & comparison with FDM/FEM	Lecture; Tutorial
2	OpenMP: shared-memory parallelism	Lecture; Tutorial
3	Efficient programming & Makefiles	Lecture; Tutorial
3	HPC Job schedulers & resource optimization	Lecture; Tutorial
3	Project support: Benchmarking & testing	Lecture; Tutorial
3	Final project presentation & peer review	Lecture; Tutorial
3	Revision	Tutorial
	Final exam	Closed book

Assessments:

Class participation	15%
In-class Test	15%
Assignments	20%
Final exam	50%

Grade Descriptors:

HD	High Distinction	85-100
D	Distinction	75-84
Cr	Credit	65-74
P	Pass	50-64
F	Fail	0-49

High Distinction 85-100
• Treatment of material evidences an advanced synthesis of ideas Demonstration of initiative, complex understanding, and analysis.
• Work is well-written and stylistically sophisticated, including appropriate referencing, clarity, and some creativity where appropriate.
• All criteria addressed to a high level.

Distinction 75-84
• Treatment of material evidences an advanced understanding of ideas Demonstration of initiative, complex understanding and analysis Work is well-written and stylistically strong.
• All criteria addressed strongly.

Credit 65-74
• Treatment of material displays a good understanding of ideas
• Work is well-written and stylistically sound, with a minimum of syntactical errors.
• All criteria addressed clearly.

Pass 50-64
• Treatment of material indicates a satisfactory understanding of ideas Work is adequately written, with some syntactical errors.
• Most criteria addressed adequately.

Fail 0-49
• Treatment of ideas indicates an inadequate understanding of ideas Written style inappropriate to task, major problems with expression.
• Most criteria not clearly or adequately addressed.

<u>Academic Integrity</u>

Students are expected to uphold the university's academic honesty principles which are an integral part of the university's core values and principles. If a student fails to observe the acceptable standards of academic honesty, they could attract penalties and even disqualification from the course in more serious circumstances. Students are responsible for knowing and observing accepted principles of research, writing and any other task which they are required to complete.

Academic dishonesty or cheating includes acts of plagiarism, misrepresentation, fabrication, failure to reference materials used properly and forgery. These may include, but are not limited to: claiming the work of others as your own, deliberately applying false and inaccurate information, copying the work of others in part or whole, allowing others in the course to copy your work in part or whole, failing to appropriately acknowledge the work of other scholars/authors through acceptable referencing standards, purchasing papers or writing papers for other students and submitting the same paper twice for the same subject.

This Academic Integrity policy applies to all students of the Zhejiang University in all programs of study, including non-graduating students. It is to reinforce the University's commitment to maintain integrity and honesty in all academic activities of the University community.

<u>Policy</u>

The foundation of good academic work is honesty. Maintaining academic integrity upholds the standards of the University. The responsibility for maintaining integrity in all the activities of the academic community lies with the students as well as the faculty and the University. Everyone in this community must work together to ensure that the values of truth, trust and justice are upheld.

Academic dishonesty affects the University's reputation and devalues the degrees offered. The University will impose serious penalties on students who are found to have violated this policy. The following penalties may be imposed:

- ✓ Expulsion
- ✓ Suspension
- ✓ Zero mark /fail grade
- ✓ Marking down
- ✓ Re-doing/re-submitting of assignments or reports, and
- ✓ Verbal or written warning.