COURSE INFORMATION

Course Code	AAM 561	Course Name	Flow Simulations Using Particles					
Type of Course	**Level of Course**	**Semester**	**Language**	**Theory**	**Application (Practice)**	**Laboratory**	**Local Credits**	**ECTS**
Elective	Graduate	-	English	3	0	0	3	6

Department	: Aerospace Engineering
Prerequisites/Requirements for Admission	: Basic computer programming course (C, Fortran, Matlab, Python etc.)
Mode of Delivery	: 100% Face to Face
Course Coordinator	: Prof. Dr. Nevsan ŞENGİL
Course Lecturer(s)	: Prof. Dr. Nevsan ŞENGİL
Course Assistant(s)	:
Course Description/Aim	: This course aims to teach the basic principles of fluid and plasma simulations using particles.
Course Contents	: Molecular Dynamics, Direct Simulation Monte Carlo, Lattice Boltzmann Method and Particle-in-Cell Method
Recommended Optional Program Components	: N/A
Compulsory Attendance	: 70%

Course Learning Outcomes

#	Learning outcome	Teaching Methods/Techniques	Assessment method(s)
At the end of this course; students will be able to:			
1	Simulate fluid flows with Molecular Dynamics Method.	Theoretical Lecture, Solving Exercises	Exams
2	Simulate rarefied gas flows with Direct Simulation Monte Carlo Method.	Theoretical Lecture, Solving Exercises	Exams
3	Simulate incompressible fluid flows with Lattice Boltzmann Method.	Theoretical Lecture, Solving Exercises	Exams
4	Simulate plasma flows with Particle-in-Cell Method.	Theoretical Lecture, Solving Exercises	Exams
5	Use MATLAB efficiently to simulate flows and parallelize the solvers.	Theoretical Lecture, Solving Exercises	Exams

Weekly Detailed Course Content

Week	Content	Recommended Resource(s)	Time (Hours)
1	Overview of Molecular Dynamic method	Textbook/ Lecture Notes	3
2	Potentials and equations of motion used in MD method	Textbook/ Lecture Notes	3
3	Calculation of macro properties	Textbook/ Lecture Notes	3
4	Optimization techniques of MD method	Textbook/ Lecture Notes	3
5	Rarefied gas dynamics and direct simulation Monte Carlo method	Textbook/ Lecture Notes	3
6	Molecule-molecule and molecule-surface collisions	Textbook/ Lecture Notes	3

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7	Stream boundary conditions	Textbook/ Lecture Notes	3
8	Calculation of macro properties/Midterm Exam	Textbook/ Lecture Notes	3
9	Introduction to Lattice Boltzmann method	Textbook/ Lecture Notes	3
10	Implementation of LBM to incompressible flows	Textbook/ Lecture Notes	3
11	Basics of plasmas and electromagnetic fields	Textbook/ Lecture Notes	3
12	Overview of Particle-in-Cell method	Textbook/ Lecture Notes	3
13	Electrostatic Model	Textbook/ Lecture Notes	3
14	Fast solution of Poisson's equations	Textbook/ Lecture Notes	3
15	Final Exam	-	-
16	Final Exam	-	-

Sources

Course Notes / Textbooks	Computer Simulation of Liquids, Allen, M. and Tildesley, D., 1994, Clarendon Press, Oxford. Computer Simulation Using Particles, Hockney, R.W. and Eastwood, J.W., 1988, Institute of Physics Publishing, Bristol, and Philadelphia. Molecular Gas Dynamics and the Direct Simulation Gas Flows, Bird, G.A., 1994, Clarendon Press, Oxford. The Lattice Boltzmann Equation for Fluid Dynamics and Beyond, Succi, S., 2004, Clarendon Press, Oxford. Plasma Physics via Computer Simulation, Birdsall, C.K. and Langdon, A.B., 1981, McGraw-Hill, NY.
Supplementary Readings	Plasma Simulations by Example, Lubos Brieda, 2019, CRC Press.

Evaluation System

Work Placement	**Number**	**Percentage of Grade (%)**
Quizzes	8	30
Homework		
Laboratory/Practice		
Report(s)		
Graduate Thesis/Project		
Seminar		
Projects		
Midterm exam(s)	1	30
Others		
Final exam	1	40
	Total	100
	Percentage of semester work	60
	Percentage of final exam	40
	Total	100

Workload Calculation

Activity	**Number**	**Time (hours)**	**Total Workload (hours)**
Course Hours	14	3	42
On-line Activity Hours			
Individual study	16	8	128
Midterm exam(s)	1	2	2
Final exam	1	3	3

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Homework			
Presentation			
Project			
		Total	175
		ECTS Credit *(Total/30)*	6

Contribution of Learning Outcomes to Program Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
LO1	2	3	2	4	5	5	5	5	4
LO2	1	4	5	4	5	5	5	2	4
LO3	2	3	5	2	5	5	5	3	5
LO4	5	5	5	5	5	5	5	5	3
LO5	3	3	4	2	5	5	5	2	1

Contribution Level: 1: “Very low”, 2: “Low”, 3: “Medium”, 4: “High”, 5: “Very High”
LO: Learning Outcome of the Course
PO: Program Outcome