Universidad Carlos III de Madrid

COURSE: Biomechanics of continuum media II: fluid mechanics		
DEGREE: Biomedical Engineering	YEAR: 2	TERM: 2

WEEKLY PROGRAMMING

WEEK	SESSION	DESCRIPTION	GROUPS		SPECIAL ROOM FOR SESSION (Computer class room, audio-visual class room)	Inidicate YES/NO If the session needs 2 teachers: Maximum 4 sessions	WEEKLY PROGRAMMING FOR STUDENT		
			LECTURE	SEMINAR			DESCRIPTION	CLASS HOURS	HOMEWORK HOURS Maximum 7 H
1	1	Fluid mechanics: principles and applications.	X			NO		1,5	1
1	2	Solids, liquids and gases. The continuum hypothesis. Density, velocity and internal energy. Local thermodynamic equilibrium. Equations of state.		X		NO	Review of thermodynamic concepts and laws.	1,5	
2	3	Coordinate systems. Eulerian and Lagrangian descriptions. Uniform flow. Steady flow. Stagnation points. Trajectories. Paths. Streamlines. Substantial derivative. Acceleration. Circulation and vorticity. Irrotational flow. Velocity potential. Stream function.	X			NO	Independent study	1,5	2
2	4	Solution of problems of flow kinematics (I).		X		NO	Homework Sheet 1	1,5	
3	5	Local flow deformation. Strain-rate tensor. Convective flow. Reynolds transport theorem.	X			NO	Independent study	1,5	2
3	6	Solution of problems of flow kinematics (II).		X		NO	Homework Sheet 2	1,5	
4	7	Continuity equation in integral form. Volume and surface forces. Stress tensor. Navier-Poisson law. Forces and moments on submerged bodies. Momentum equation in integral form. Angular momentum equation.	X			NO	Independent study	1,5	5
4	8	Applications of the continuity and momentum equations in integral form		X		NO	Homework Sheet 3	1,5	
5	9	Heat conduction vector. Energy equation in integral form.	X			NO	Independent study	1,5	7
5	10	Applications of the conservation equations in integral form		X		NO	Homework Sheet 4	1,5	
6	11	Applications of the conservation equations in integral form	X			NO	Independent study	1,5	7
6	12	Navier-Stokes equations. Initial and boundary conditions. Bernoulli's equation.		X		NO	Homework Sheet 5	1,5	

7	13	Applications of the conservation equations in differential form	X			NO	Independent study	1,5	7
7	14	Applications of the conservation equations in differential form		X		NO	Homework Sheet 6	1,5	
8	15	MID-TERM EXAM	X			YES	Independent study	1,5	7
8	16	Dimensional analysis. The Pi theorem. Applications.		X		NO	Independent study	1,5	
9	17	Applications of dimensional analysis.	X			NO	Independent study	1,5	7
9	18	Nondimensionalization of the Navier-Stokes equations. Dimensionless numbers in fluid mechanics. Applications.		X		NO	Homework Sheet 9	1,5	
10	19	Viscous flow in channels and pipes. Poiseuille and Couette solutions.	X			NO	Independent study	1,5	7
10	20	Biomedical applications of viscous flow in channels and pipes.		X		NO	Independent study	1,5	
11	21	Flows with slowly varying cross section. Unsteady effects in viscous flows: Womersley flow	X			NO	Homework Sheet 10	1,5	7
11	22	Applications of viscous flow in channels and pipes: flow in airways. Introduction to low-Reynolds numer (Stokes) flow		X		NO	Independent study	1,5	
12	23	Stokes flow around a sphere: application to cell locomotion	X			NO	Independent study	1,5	7
12	24	Life and locomotion at low Reynolds numbers		X		NO	Homework Sheet 11	1,5	
13	25	Introduction to micro and nano fluidics	X			NO	Independent study	1,5	7
13	26	Applications: lab-on-a-chip technologies		X		NO	Homework Sheet 12	1,5	
14	27	Introduction to non-newtonian fluid mechanics	X			NO	Independent study	1,5	7
14	28	Non-newtonian fluids in biology and medicine		X		NO	Homework Sheet 13	1,5	
SUBTOTAL								**42 + 80 = 122**	
15		Tutorials, Handing in, etc							
16-18		Assessment						3	10
TOTAL								**135**	

LABORATORIES CLASSES PROGRAMMING*						
SESSION	WEEK	DESCRIPTION	LABORATORY	WEEKLY PROGRAMMING FOR STUDENT		
				DESCRIPTION	CLASS HOURS	HOMEWORK HOURS Maximum 7 H
1	11	Numerical solution of the flow in a duct: writing down the equations is a suitable form for the numerical simulation	Computer room		1,5	
2	12	Numerical solution of the flow in a duct: numerical computation of the sinusoidal Womersley flow.	Computer room		1,5	
3	13	Numerical solution of the flow in a duct: numerical simulation of the flow in an artery	Computer room		1,5	2
4	14	Flow at low Reynolds numbers.	Fluid mechanics laboratory		1,5	7
TOTAL					15	

* 6 hours of complementary laboratories classes in EPS