UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2022/2023
MASTER'S DEGREE (MSC)	BIOMEDICAL ENGINEERING
SUBJECT	TRASNSPORTATION PHOENOMENA IN BIOLOGICAL SYSTEMS
TYPE OF EDUCATIONAL ACTIVITY	C
AMBIT	20909-Attivit Formative Affini o Integrative
CODE	20276
SCIENTIFIC SECTOR(S)	ING-IND/24
HEAD PROFESSOR(S)	BRUCATO VALERIO MARIA BARTOLO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**BRUCATO VALERIO MARIA BARTOLO** Tuesday 14:00 15:00 Studio del docente, Viale delle Scienze, Edificio 6, Stanza 3019, Palermo Wednesda 14:00 15:00 Studio del docente, Viale delle Scienze, Edificio 6, Stanza 3019, Palermo Thursday 14:00 15:00 Studio del docente, Viale delle Scienze, Edificio 6, Stanza 3019, Palermo

DOCENTE: Prof. VALERIO MARIA BARTOLO BRUCATO

PREREQUISITES	Consolidated knowledge on: algebra, functions of one or more variable, infinitesimal calculus, partial derivative equations, mechanics, chemistry, phase equilibrium and state diagrams.
LEARNING OUTCOMES	knowledge and understanding - After the course the student will become conscious of problems related to transport phenomena and will became familiar with mass, energy and momentum balance equations as well as related transport constitutive models. - The student will be able to select and use the needed and appropriate relationships for biomedical engineering processes. making judgements - The student will be able to autonomous evaluate transport phenomena relationships applicability, results reliability and confidence, boundary conditions to apply to transport phenomena problems. Skills in application knowledge and understanding - learning of new and more complex approach to problems involving the course topics will be easier as fundamentals and logic approach scheme to face problems are current contents of the course. communication skills - The student will acquire the skill of state and tranfer problems related to course topics by the use of the appropriate scheme mathematics and terminology. Learning skills - By the acquired knowledge on transport phenomena the student will own the fundamental approach of balance equations, both macroscopic and microscopic, to complex problems; - furthermore he will know the difference between qualitative and quantitative approach to biomedical engineering. - The student will have learned the structure and the relationships between the microscopic balance equations, as well as how to solve relevant and complex problems of transport phenomena. - It will also include the simplifications to be applied for a qualitative and quantitative approach to transport phenomena in the design of biomedical engineering equipment.
ASSESSMENT METHODS	The assessment will be based on class test + oral. The class test will assess only the admission to the oral. The following criteria and score table will be applied to oral and the final evaluation, obtained by summing the individual criteria score will result in a pass if ranging from18 to 30. Indicator - Knowledge and competence of contents Descriptor and score range: Excellent 10 Autonomous and effective 8-9 Acceptable 6-7 Fragmentary or partly superficial 4-5 Inadequate 0-3 Indicator - Applicative skill, precision, logical-thematic coherence Descriptor and score range: Excellent 10 Adequate 8-9 Acceptable also if partly driven 6-7 Limited 4-5 Inadequate 0-3 Indicator - Expression and terminology, reprocessing skills and multi-disciplinary connections Descriptor and score range: Excellent 10 Effective and well-structured 8-9 Generally satisfactory 6-7 Hesitant and rough 4-5 Inadequate 0-3 The exam and the related evaluation will be the same for non-attending students.
EDUCATIONAL OBJECTIVES	The course aim to train the students on fundamentals and application of transport phenomena knowledge for professional work as well as applied research on biomedical devices and process design.
TEACHING METHODS	Lectures + practical class.
SUGGESTED BIBLIOGRAPHY	Bird, R. Byron, Stewart, Warren E., Lightfoot, Edwin N., Transport Phenomena - revised 2nd Edition, Wiley (2007), ISBN: 978-0470115398 R. Mauri – Fenomeni di trasporto. – Pisa University Press; 3 edizione (9 luglio 2014), ISBN: 978-8867413522

SYLLABUS

Hrs	Frontal teaching
9	Recall of stresses, definition of the extra-stress tensor, fluid rheology. Microscopic total mass balance. Quantity balance of microscopic motion. Microscopic balance of energy and mechanical energy. Dimensional analysis of microscopic balance equations. Identification of boundary conditions and solution of microscopic balance equations for stationary physical cases also for fluids with complex rheology and for non-stationary physical cases with distributed parameters.
9	Fourier's law, dependence of the conductivity on temperature and pressure. Balance of thermal energy and boundary conditions; stationary non-stationary heat flow in various geometries. Heat conduction with thermal generation (Joule effect electric energy, viscous dissipation, chemical reaction); transport of heat in laminar convection in a tube; cooling fin; natural convection. Insights into Irradiation: Lambert's law, view factors.
9	Dependence of diffusivity on temperature and pressure. Material balance and boundary conditions. Equimolar counterdiffusion and diffusion in stagnant component, diffusion with chemical reaction on the wall. Diffusion under transient conditions. Solution for thin penetration thicknesses, instantaneous and medium exchange coefficients, limits of applicability of the solution. Microscopic balances of matter, biological interfaces.
5	Compartmental models of tissues, organs and the human body.

Hrs	Practice
16	Calculations related to stationary conduction with generation, in solids of various geometries. Applications of calculation of the microscopic balance of thermal energy in thermal transients with concentrated and distributed parameters. Applications of calculation of the macroscopic material balance in thermal transients with concentrated and distributed parameters. Computational applications of compartmental models of tissues, organs and human body.