COURSE INFORMATION

Course Code	AAM 545	Course Name	Advanced Heat and Mass Transfer					
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	: None
Mode of delivery	: Face to face
Course coordinator	: Asst. Prof. Dr Mohamed Salem ELMNEFI
Course lecturer(s)	: Asst. Prof. Dr Mohamed Salem ELMNEFI
Course assistant(s)	: None
Course description/aim	: This course is aimed at graduate engineers and scientists with the view of deepening their understanding of basic mechanisms controlling heat, mass and momentum transfer processes. Following a presentation of classical theories and analytical solutions for specific heat and mass transfer problems, the course will aim to show how modern computational techniques can be applied to obtain solutions to more general problems.
Course contents	Steady state heat conduction with heat generation, transient heat conduction, extended surfaces, radiant heat transfer, equations of motions of compressible flow, viscous fluid, turbulent boundary layer theory, incompressible laminar flow, heat transfer through a laminar boundary layer. Incompressible turbulent, heat and mass transfer through a turbulent boundary layer, and mass transfer in laminar and turbulent flow.
Recommended optional program components	:
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	Identify previous heat and mass transfer research and apply tools and techniques for to engineering research and development programs.	Theoretical Lecture	Exams/Homeworks/Project
2	Clarify the significance of the various terms appearing in the governing equations.	Theoretical Lecture	Exams/Homeworks/Project
3	Present the concepts of boundary layer and separation.	Theoretical Lecture	Exams/Homeworks/Project
4	Broaden the understanding of the role of fins on heat transfer surfaces.	Theoretical Lecture	Exams/Homeworks/Project
5	Expand the treatment of radiation problems to encompass absorbing and introduce a wider range of network and computational schemes for solution of radiation problems.	Theoretical Lecture	Exams/Homeworks/Project
6	Determine the steady state and transient temperature distribution in various solid geometries of practical importance.	Theoretical Lecture	Exams/Homeworks/Project

7	Determine the appropriate transport phenomena for any process involving heat and mass transfer.	Theoretical Lecture	Exams/Homeworks/Project

Weekly Detailed Course Content

Week	Content	Recommended Resource(s)	Time (Hours)
1	Introduction and review of Heat Transfer Fundamentals	Textbook and Lecture Notes	3
2	Steady state heat conduction with internal heat generation	Textbook and Lecture Notes	3
3	Extended surfaces (fins), optimum distribution of fin material, fin efficiency, annular fins	Textbook and Lecture Notes	3
4	Unsteady State heat conduction	Textbook and Lecture Notes	3
5	Radiant heat transfer, definitions of surface properties, Kirchhoff's Laws, Stefan Boltzmann equation	Textbook and Lecture Notes	3
6	Gray bodies, view factor, energy exchange in gray enclosures with and without absorbing gases	Textbook and Lecture Notes	3
7	Equations of motions of a compressible, viscous fluid; Navier-Stokes equation; significance of Reynolds number	Textbook and Lecture Notes	3
8	Laminar boundary theory in incompressible fluid flow; flow over flat plate, separation; Von Karman momentum equation /Midterm Exam	Textbook and Lecture Notes	3
9	Steady Laminar and Turbulent Heat Transfer in External and Internal Flows	Textbook and Lecture Notes	3
10	Unsteady Laminar and Turbulent Forced Convection in Ducts and on Plates	Textbook and Lecture Notes	3
11	Laminar, forced and natural convection	Textbook and Lecture Notes	3
12	Incompressible turbulent flow; heat and mass transfer through a turbulent boundary layer; modified energy equation; mixing length theory	Textbook and Lecture Notes	3
13	Reynolds, Taylor and Martinelli analogues; applications to flow over a flat and down a duct; turbulent Prandtl number and limitations of the analogues of heat and mass transfer	Textbook and Lecture Notes	3
14	J factors. Mass transfer in laminar and turbulent flow	Textbook and Lecture Notes	3
15	Final Exam		
16	Final Exam		

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Sources

Course notes/textbooks	: Kays, “Convective heat and mass transfer”, McGraw-Hill. Cebeci and Bradshaw, “Momentum transfer in boundary layers”, Mc Graw-Hill Eckert and Drake, Jr, Analysis of heat and mass transfer- McGraw-Hill Schlichting, “Boundary layer theory”, Mc Graw-Hill
Readings	: None
Supplemental readings	: None
References	: None

Evaluation System

Work Placement	**Number**	**Percentage of Grade (%)**
Attendance		
Quizzes		
Homework	4	20
Laboratory/Practice		
Report(s)		
Graduate Thesis/Project		
Seminar		
Presentation		
Projects	1	30
Midterm exam(s)	1	20
Others		
Final exam	1	30
	Total	100
	Percentage of semester work	70
	Percentage of final exam	30
	Total	100

Workload Calculation

Activity	**Number**	**Time (hours)**	**Total Workload (hours)**
Course Hours	14	3	42
On-line Activity Hours	0	0	0
Individual study	16	3	48
Lab practice	0	0	0
Midterm exam(s)	1	3	3
Final exam	1	3	3
Homework	4	6	24
Presentation	2	3	6
Project	2	24	48
		Total	174
		ECTS Credit *(Total/30)*	6

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Contribution of Learning Outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
LO1	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
LO2	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
LO3	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
LO4	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
LO5	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
LO6	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
LO7	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**

Contribution Level: 1 Very low, 2 Low, 3 Medium, 4 High, 5 Very High