EASTERN MEDITERRANEAN UNIVERSITY Department of Mechanical Engineering			
Course Code ME 544	**Course Title** **Advanced Heat Transfer**	**Prepared by:** **I. Sezai**	**Credit Hours** (3,0) 3

2016-2017 Spring

I. Catalogue Description:
This course is intended as a one semester course for first year graduate students on convection heat transfer. Topics to be covered include basic concepts in heat transfer, differential formulation of the continuity, momentum and energy equations, exact solution of one-dimensional flow problems, boundary layer flow, approximate solutions using the integral method, heat transfer in channel flow, correlation equations in forced and free convection, flow through porous media, convection in microchannels.

II.Prerequisite by Topic:
Students are expected to have a basic knowledge of heat transfer and fluid dynamics. Students are also expected to be proficient in applying mathematics (e.g., integration, differentiation, and differential equations), and thermodynamics (e.g., the first law).

III. Textbook :
L. M. Jiji, *Heat Convection*, 2nd Edition, Springer, New York, 2010.
References:
W.M. Kays and M.E. Crawford, *Convective Heat and Mass Transfer*, Mc Graw Hill
L.C. Burmeister, Convective Heat Transfer, Wiley
P.H. Oosthuizen and D. Naylor, *Introduction to Convection Heat Transfer*, McGraw Hill

IV. Course Objectives:
1. To cover the basic principles and equations of convection heat transfer.
2. To present numerous and diverse real-world engineering examples to give students a feel for how heat transfer is applied in engineering practice.
3. To develop an intuitive understanding of convection heat transfer by emphasizing the physics, and visual aids.

V.Course Outline:

Week 1	**Basic Concepts:** convection, the continuum and thermodynamic equilibrium, Newton's law of cooling, radiation, differential formulation of basic laws.
Week 2	**Differential Formulation of Basic Laws** Conservation of mass, momentum and energy equations, the Boussinesq approximation, non-dimensional form of the governing equations, Nusselt number.
Week 3	**Exact solution of one dimensional flows:** Couette and Poiseuille flows, rotating flows.
Week 4	**Diffusion (4 Classes)** Diffusion mechanisms, steady-state and nonsteady-state diffusion, factors that influence diffusion
Week 5	**Boundary Layer Flow - Application to External Flows:** Boundary layer concept, the governing equations, simplification of momentum and energy equations. Solutions of external flow: flow over a flat plate with constant temperature and constant heat flux conditions. Blausius solution, Pohlhausen's solution.
Week 6	**Appoximate Solutions - The integral Method:** Integral method approximation. Integral formulation of mass, momentum and energy equations. Integral solutions of flow over a flat plate
Week 7	**Midterm Examination**
Week 8	**Heat transfer in Channel Flow:** Hydrodynamic and thermal entry regions; analytic and numerical solutions. Fully developed region; uniform surface flux and uniform surface temperature cases. Thermal entrance region for laminar flow through tubes; Graetz solution.
Week 9	**Free Convection:** Laminar free convection over a vertical plate with uniform temperature; similarity transformation. Laminar free convection over a vertical plate with uniform surface heat flux. Inclined plates. Integral solution of momentum and energy equations.
Week 10	**Convection in External Turbulent Flow**
Week 11	**Convection in Turbulent Channel Flow**

Week 12	**Correlation Equations - Forced and Free Convection:** External forced convection correlations; flow over a flat plate, cylinder and sphere. Internal forced convection correlations for entrance and fully developed regions. Flow in non-circular channels. Free convection correlations.
Week 13	**Convective Heat Transfer Through Porous Media:** Parea averaged velocity, Darcy flow model. Energy equation. Boundary layer solutions for two-dimensional forced convection. Fully developed duct flow.Natural convection in porous media. Non-Darcy and other effects.
Week 14	**Convection in Microchannels:** Continuum, surface forces, mean free path, macro and micro channels. General features; Transition to turbulent flow, Nusselt number. Governing equations; compressibility, axial conduction, dissipation. Velocity slip. Analytic solutions; Slip flow, Couette flow with viscous dissipation. Poiseuille channel flow. Fully developed Poiseuille flow in microtubes

VI. Class/Laboratory Schedule:

Three 50 minutes lectures per week.

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VII. Evaluation of Outcomes:

Mid-term 1	30%
Mid-term 2	30%
Final Examination	40%