CONVECTIVE HEAT TRANSFER

SWAYAM Prabha Course Code- M16

PROFESSOR'S NAME	Dr. Arvind Pattamatta, Prof. Ajit K. Kolar
DEPARTMENT	Department of Mechanical Engineering
INSTITUTE	IIT Madras
COURSE OUTLINE	**Governing Equations:** Continuity, Momentum and Energy Equations and their derivations in different coordinate systems,Boundary layer Approximations to momentum and energy. **Laminar External flow and heat transfer:** (a) Similarity solutions for flat plate (Blasius solution), flows with pressure gradient (Falkner-Skan and Eckert solutions), and flow with transpiration, (b) Integral method solutions for flow over an isothermal flat plate, flat plate with constant heat flux and with varying surface temperature (Duhamel's method), flows with pressure gradient (von Karman-Pohlhausen method). **Laminar internal flow and heat transfer:** (a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region of ducts and channels (Graetz solution), heat transfer in the combined entrance region, (b) Integral method for internal flows with different wall boundary conditions. **Natural Convection heat transfer:** Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Similarity solutions for Laminar flow past a vertical plate with constant wall temperature and heat flux conditions, Integral method for natural convection flow past vertical plate, effects of inclination, Natural convection in enclosures, mixed convection heat transfer past vertical plate and in enclosures. **Turbulent convection:** Governing equations for averaged turbulent flow field (RANS),Analogies between heat and Mass transfer (Reynolds, Prandtl-Taylor and von Karman Analogies), Turbulence Models (Zero, one and two equation models), Turbulent flow and heat transfer across flat plate and circular tube, Turbulent natural convection heat transfer, Empirical correlations for different configurations.

COURSE DETAILS

S. No	Module ID/ Lecture ID	Lecture Title/Topic
1	**L1**	Introduction to convective heat transfer - Part 1
2	**L2**	Introduction to convective heat transfer - Part 2
3	**L3**	Continuity Equation
4	**L4**	Momentum and Energy Equations
5	**L5**	Energy Equation
6	**L6**	Reynolds Transport Theorem
7	**L7**	Entrophy Generation and streamfunction-vorticity formulation
8	**L8**	Couette flow - Part 1
9	**L9**	Couette flow - Part 2
10	**L10**	Couette flow - Part 3
11	**L11**	Boundary layer approximation
12	**L12**	Laminar External flow past flat plate (Blasius Similarity Solution)
13	**L13**	Numerical solution to the Blasius equation and similarity solution to heat transfer
14	**L14**	Pohlhausen similarity solution and flows including pressure gradient (Falkner-Skan)
15	**L15**	Falkner skan solutions for heat transfer
16	**L16**	Similarity solution for flow and heat transfer with transpiration at walls
17	**L17**	Thermal boundary layer in high speed flows
18	**L18**	Approximate(Integral) methods for laminar external flow and heat transfer
19	**L19**	Integral method for laminar external thermal boundary layer over isothermal surface

20	**L20**	Integral method for flows with pressure gradient (von Karman-Pohlhausen method)
21	**L21**	Integral method with pressure gradient: heat transfer
22	**L22**	Heat transfer across a circular cylinder: Walz approximation
23	**L23**	Duhamel's method for varying surface temperature
24	**L24**	Laminar External heat transfer with non uniform surface temperature
25	**L25**	Laminar internal forced convection - fundamentals
26	**L26**	Hydrodynamically and thermally fully developed internal laminar flows
27	**L27**	Fully developed laminar internal flow and heat transfer
28	**L28**	Shooting method for fully developed heat transfer and thermal entry length problem
29	**L29**	Thermal entry length problem with plug velocity profile: Graetz problem
30	**L30**	Extended Graetz problem for parabolic velocity profile
31	**L31**	Extended Graetz problem
32	**L32**	Extended Graetz problem with wall flux boundary condition
33	**L33**	Approximate method for laminar internal flows
34	**L34**	Integral method for thermal entry length problem
35	**L35**	Introduction to Natural Convection Heat Transfer
36	**L36**	Similarity Solution in Natural Convection for Vertical isothermal Plate - Part 1
37	**L37**	Similarity Solution in Natural Convection for Vertical isothermal Plate - Part 2
38	**L38**	Similarity Solution in Natural Convection for Vertical isoflux Plate
39	**L39**	Approximate Method in Natural Convection Heat Transfer
40	**L40**	Natural Convection in Other Configurations

References if Any:

Textbooks: 1. Convective Heat and Mass Transfer, 4th Edition by W. Kays, M. Crawford and B. Weigand, McGraw Hill International, 2005. NPTEL http://nptel.iitm.ac.in Mechanical Engineering Pre-requisites: Heat Transfer, Fluid Mechanics, Differential Equations Coordinators: Dr. Arvind Pattamatta Department of Mechanical EngineeringIIT Madras Prof. Ajit K. Kolar Department of Mechanical EngineeringIIT Madras 2. Convective Heat Transfer, 2nd Edition by S.Kakac and Y. Yener, CRC Press, 1995. 3. Convection Heat Transfer, 3rd Edition by A.Bejan, John Wiley, 2004

References: 1. Fundamentals of Heat and Mass Transfer, 7th Edition by F.P. Incropera and D. Dewitt, John Wiley, 2011. 2. Boundary Layer Theory, 8th Edition by H.Schlichting and K. Gersten,Springer-Verlag, 2000.