



BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

SECOND SEMESTER 2020-2021
Course Handout Part II

Date: 06/01/2021

In addition to Part-I* (General Handout for all courses appended to the time table), this portion gives further specific details regarding the course.

Course No. : ME G534
Course Title : CONVECTIVE HEAT AND MASS TRANSFER
Course Instructor : Chennu Ranganayakulu
Course Coordinator : Chennu Ranganayakulu

1. Scope and Objective of the Course:

This course has been designed to discuss various modes of convective heat transfers possible in real time applications coupled with relevant theories. It covers possible combinations of laminar and turbulent flows, internal and external flows, and natural and forced convection with mass transfer aspects. The course primarily useful for persons who want to pursue research in Heat Transfer area and covers the following topics: Boundary Layer Concepts; Laminar external flow, similarity solutions; Laminar duct flow, developing and fully developed flow; External natural convection, mixed convection; Natural convection in enclosures; Turbulent boundary layer flow, Mixing-Length model, external flows; Turbulent duct flow, friction factor and pressure drop, heat transfer coefficient; Convection during condensation and boiling; Mass transfer.

2. Text Book (TB):

1. A. Bejan, *Convective Heat Transfer*, John Wiley and Sons, Fourth Edition, 2013.
2. F. P Incropera, D.P Dewitt, T.L Bergman, A.S Lavine, K.N Seetahramu & T.R Seetharam, *Fundamentals of Heat and Mass Transfer*, Wiley India Pvt. Ltd, 2013.

3. Reference Book (RB):

1. C. Ranganayakulu and K.N Seetharamu, *Compact Heat Exchangers – Analysis, Design and Optimization using FEM and CFD Approach*, John Wiley and Sons, ASME Press, 2018.
2. RB2: J. G. Collier, and J. R. Thome, *Convective Boiling and Condensation*, Oxford University Press, Third Edition, 1996.

4. Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Chapter/ Section
1-3	Fundamental Principles	Basic Heat Transfer, Conservation equations, Rules of scale analysis, and Heat lines for visualization of Convection.	RB1: 1.1-1.3, 3.3.1 TB1: 1.5 - 1.6

4-8	Laminar Boundary Layer Flows	Concepts of boundary layer – Velocity, thermal and Concentration boundary layers, Scale analysis, Integral solutions and Similarity solutions.	TB2: 6.1 TB1: 2.1 – 2.5
9-14	Laminar Duct Flow	Hydrodynamic entrance length, Fully developed flow, Hydraulic Diameter & Pressure drop, Heat transfer in developing and fully developed duct flows.	TB1 3.1 – 3.5
15-19	External Natural Convection	Introduction to Natural convection, Laminar boundary layer equations, Scale analysis, Integral and Similarity solution, Uniform wall heat flux, Mixed convection, and Heat transfer with turbulence effects.	TB1 4.1 – 4.6; & 4.10 – 4.11
20-23	Internal Natural Convection	Transient heating from the side and Enclosures heated from below.	TB1 5.1; & 5.4 – 5.5
24-27	Turbulent Boundary Layer Flow	Large-scale structure, Time-averaged equations, Mixing length model, Wall friction and Heat transfer in boundary layer flow, and Other external flows.	TB1 7.1 – 7.7; & 7.9
28-30	Turbulent Duct Flow	Velocity distribution, Friction factor and pressure drop, Heat transfer coefficient, and Total heat transfer rate.	TB1 8.1 – 8.4
31-32	Combined Convection and Radiation (Multimode Heat transfer)	Introduction to Radiation Heat transfer and Multimode Heat transfer	TB2: 12.1-12.2 & 13.3
33-36	Convection with Change of Phase	Condensation and Boiling	TB1 10.1 – 10.2
37-40	Mass Transfer	Properties of mixtures, Mass concentration, Mass diffusivities, Conservation of Species, Mass Diffusion equation and Laminar forced convection.	TB1 11.1 – 11.5 TB2 14.4

5. Evaluation Scheme:

Component	Duration (Min)	Weightage (%)	Date & Time	Nature of Component
Assignments	-	10	Continuous throughout the semester	Open Book
Seminars/case studies/projects	-	20	Continuous throughout the semester	Open Book
Mid semester Test	75	30	March 2021 (Date TBA)	Mostly Open book. Closed book can be considered depends on availability of students in campus at later date.
Comprehensive Exam	150	40	As per the announced time table	

6. Chamber Consultation Hour: To be announced in the class.

7. **Notices:** All notices and updates concerning the course will be uploaded on the Nalanda.
8. **Make-up Policy:** Make-up request for tests shall be granted only for the *genuine* case with sufficient evidence. Request letter duly signed by the student must reach the undersigned at least two days before the scheduled test.
9. **Academic Integrity Policy:** It is expected that in compliance with institute rules and regulations, academic integrity should be adhered to in all the evaluation components. No type of academic dishonesty is acceptable and malpractice in any form will have serious implications.

C. Ranganayakulu
INSTRUCTOR-IN-CHARGE
(ME G534)

Part I: ME G534 Convective Heat and Mass Transfer 5*

Conservation equations, boundary layers, free convection, forced convection. Heat transfer in laminar and turbulent, internal as well as external flows, mixed convection. Combined convection and radiation. Boiling and Condensation. Molecular diffusion in fluids, mass transfer coefficient. Simultaneous heat and mass transfer; Applications.