Course Type	Course Code	Name of Course	L	T	P	Credit
DC	NMEC524	Convection and Two-Phase Flow	3	1	0	4

Course Objective
Advanced treatment of fundamental aspects of convection and two-phase heat transfer. Students pursuing research in the field of convection/two-phase flow can utilize the knowledge for finding new things in this area
Learning Outcomes
Upon successful completion of this course, students will: • have a broad understanding regarding fundamental aspects of convection and two-phase heat transfer. • be able to offer ideas about how to analyze various multiphase problems.

Unit No.	Topics to be Covered Lecture	Lecture Hours	Learning Outcomes
1	Introduction to convection, Derivation of governing mass momentum and energy balance equations, Scale analysis and concept of heat line	8+2	Students will have concept on convection
2	Boundary layer concept in external flow: Forced convection heat transfer over a flat plate, velocity and thermal boundary layer, Scale analysis, Integral solutions, Similarity solutions	7+3	Students will have concept on flow over a flat plate
3	Internal forced convection: Hydrodynamic entrance length, Review of duct flow, Thermally and hydraulically developed flow through circular tube: uniform surface heat flux, uniform surface temperature, The Graetz problem	7+3	Students will have concept on Internal forced convection
4	Laminar boundary layer equations for natural convection, Boussinesq approximation, Scale analysis for high and low Pr number, Integral and similarity solutions, combined natural and forced convection (Mixed Convection)	9+3	Students will have concept on natural convection
5	Film condensation along a flat plate, Introduction to two phase flow, Flow regimes for single and two component vertical and horizontal flow, Conservation equations based on homogeneous flow, drift flux model, separated flow model (multi-fluid model), Pool boiling curve, film boiling, flow boiling, Experimental methods for boiling and two-phase flow	11+3	Students will have concept on two phase flow, boiling, and condensation.
	Total	42+14	

Text Books:

1. Adrian Bejan, Convective heat transfer, John Wiley & Sons, 4th Edition, 2013.

2. W. M. Kays and M. E. Crawford, Convective heat and mass transfer, McGraw-Hill, 4th Edition, 2017.

References:

1. Louis Bermister, Convective heat transfer, 2nd Edition, 1993.

2. Latif M. Jiji., "Heat Convection", Springer, 3rd Edition, 2009.

3. Patrick H. Oosthuizen and David Naylor, An introduction convective heat transfer, McGraw-Hill, 2nd Edition, 1990.

4. L. S. Tong, Boiling heat transfer and two phase flow, John Wiley & Sons, 1st Edition, 1965.

5. P. B. Whalley, Boiling, condensation, and gas-liquid flow, Oxford university press, 1st Revised Edition, 1999.