TRANSPORT PHENOMENA OF NON-NEWTONIAN FLUIDS

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PRE-REQUISITES : Fluid Mechanics, Heat Transfer, Mass Transfer

INTENDED AUDIENCE : Chemical Engineering, Biotechnology, Food Engineering, Mechanical Engineering

COURSE OUTLINE :

Non-Newtonian fluids are often encountered in our daily life as well as in many industries. Some of the daily-life applications include personal care products such as cosmetics, gels, pastes; food stuffs such as sandwich spreads, ketchup, chocolate, soups, etc. Some of the industrial applications include processing of many polymers, paints and detergents, degassing of polymeric melts and glasses, use of non-Newtonian polymers in enhanced oil recovery, non-Newtonian fluidized beds, wastewater treatment, production of polymeric alloys and ceramics via liquid routes, pharmaceutical products wherein the polymer thickening agents are used to enhance their stability for extended shelf-life, pulp and paper industries, etc. Because of aforementioned overwhelming applications, it is required for both undergraduate and postgraduate students to acquire enough academic experience related to the momentum, heat and mass transfer phenomena associated with non-Newtonian fluids. Thus, in this course, details of types and mathematical models of non-Newtonian fluids, and their momentum, heat and mass transport phenomena are discussed along with the corresponding boundary layer flows. Problems would be discussed on the cases of engineering applications where combined momentum and heat transfer, combined momentum and mass transfer, combined mass and heat transfer, combined heat and mass transport along with homogenous and/or heterogeneous reactions are involved simultaneously.

ABOUT INSTRUCTOR :

Prof. Nanda Kishore completed PhD from Indian Institute of Technology (IIT) Kanpur in 2008 and presently is a full professor in the Department of Chemical Engineering of IIT Guwahati, India. He was Brunel Research Fellow from Dec. 21, 2009 to March 31, 2011 at School of Engineering Sciences, University of Southampton, UK. He was a visiting researcher of Department of Chemical and Processing Engineering, University of Surrey, Guildford, United Kingdom from June 2016 to July 2016. He received Young Scientist Research Award in 2016 from DAE-BRNS; IEI Young Engineers Award for the year 2015; Young Scientist Research Grant from Science and Engineering Research Board of Department of Science and Technology, Government of India, 2013.

COURSE PLAN :

Week 1 : Basics of Non-Newtonian Fluids
L – 1: Newtonian Fluids and Classification of Non-Newtonian Fluids
L – 2: Time Independent Non-Newtonian Fluids
L – 3: Time Dependent Non-Newtonian Fluids and Viscoelastic Non-Newtonian Fluids
L – 4: Viscoelastic Non-Newtonian Fluids
Week 2 : Rheology Measuring Instruments
L – 5: Capillary Viscometers
L – 6: Capillary Viscometers – Errors and Corrections
L – 7: Capillary Viscometers – Errors and Corrections II
Week 3 : Rheology Measuring Instruments II
L – 8: Rotational Rheometers
L – 9: Rotational Viscometers – II
L – 10: Rotational Viscometers – III
Week 4 : Equations of Change
L – 11: Continuum Hypothesis and Transport Mechanisms
L – 12: Equations of Change for Isothermal Systems
L – 13: Equations of Change for Non-Isothermal Systems
Week 5 : Momentum Transfer of Non-Newtonian Fluids
L – 14: Time Independent Fluids Flow Through Pipes
L – 15: Power-law and Ellis Model Fluids Flow Through Pipes
L – 16: Bingham Plastic Fluids Flow through Pipes
L – 17: Herschel-Bulkley Fluids Flow through Pipes

Week 6 : Momentum Transfer of Non-Newtonian Fluids-2
L – 18: Transition and Turbulent Flow of GNF in Pipes
L – 19: Transition and Turbulent Flow of GNF in Pipes – 2
L – 20: Laminar flow of GNFs between Parallel Plates and along Inclined Surface
L – 21: Laminar flow of GNFs along Inclined Surface and Concentric Annulus
Week 7 : Flow of Non-Newtonian Fluids through Porous Media
L – 22: Flow of Non-Newtonian Fluids through Packed Beds
L – 23: Dispersion in Packed Beds: Non-Newtonian Effects
L – 24: Liquid-Solid Fluidization by Power-law Liquids
Week 8 : Heat Transfer Phenomena of Non-Newtonian Fluids
L – 25: Free Convection between Two Vertical Plates
L – 26: Viscous Heat Generation
L – 27: Temperature distribution in fluids confined between co-axial cylinders
Week 9 : Heat Transfer Phenomena of Non-Newtonian Fluids-2
L – 28: Temperature distribution for FDF of Newtonian fluids in tubes
L – 29: Heat Transfer Combined with Chemical Reactions
L – 30: Transpiration Cooling
Week 10 : Mass Transfer Phenomena of Non-Newtonian Fluids
L – 31: Basics of MT; Diffusion Through Stagnant Gas Film
L – 32: Non-Isothermal Diffusive MT and Forced Convective MT
L – 33: Simultaneous Heat and Mass Transfer
L – 34: Mass Transfer Combined with Chemical Reactions
Week 11 : Simultaneous HT, MT and Chemical Reactions
L – 35: Quasi-Steady Analysis of Simultaneous HT, MT and Chemical Reaction
L – 36: Quasi-Steady Analysis of Simultaneous HT and MT – I
L – 37: Quasi-Steady Analysis of Simultaneous HT and MT – II
L – 38: Quasi-Steady Analysis of Simultaneous HT and MT – III
Week 12 : Boundary Layer Flows
L – 39: Momentum and Thermal Boundary Layer Flows
L – 40: Momentum Boundary Layer Thickness of Non-Newtonian Fluids
L – 41: Thermal and Concentration Boundary Layer Thickness of Non-Newtonian Fluids