## ADVANCED HEAT AND MASS TRANSFER – 2020/2021

### Theoretical questions

1. The Fourier's law and the general form of the Heat Equation: physical significance of terms, properties involved, boundary conditions, assumptions.
2. Thermal resistances: definition, contact resistance, thermal resistances in parallel and in series, overall heat transfer coefficient, examples for different geometries.
3. Discuss the critical radius of insulation. What is the significance of critical radius of insulation with reference to (a) insulation of pipes to reduce the heat flow, and (b) insulation of the electric cables?
4. Fins: efficiency, effectiveness, influence of thermal conductivity, convection coefficient, geometry. Examples.
5. Derive the expression for the mid-plane temperature for a plane wall of thickness 2L with a uniformly distributed heat generation q per unit volume, where Tw is the temperature on the either side of the wall and k is the thermal conductivity of the wall material.
6. Methods for the solution of the multi-dimensional heat conduction problems. What is a conduction shape factor?
7. The lumped parameter method for transient conduction: description, applicability, time constant, parameters and non-dimensional numbers involved. If not applicable, describe briefly alternative methods.
8. Discuss development of velocity, temperature and concentration boundary layers for flow of fluid ($U_\infty$, $T_\infty$) over a thin flat plate held parallel to flow. Further discuss on the main transport coefficients (friction, heat and mass transfer coefficients) and the effect of boundary layer development on them. Support the discussion with appropriate figures.
9. Boundary layers equations: description, assumptions and approximations, parameters, local and average transport coefficient. Reynolds and Chilton-Colburn analogies.
10. Circular cylinder in cross flow: physical description, local convection coefficient, separation.
11. Internal flows: entry region and fully developed flow.
12. Internal flows: the mean velocity and the mean temperature. Hydraulic diameter. How does the mean temperature of the fluid vary with distance from the entrance (for uniform heat flux and uniform surface temperature)?
13. Internal flows: fully developed flow pressure drops and heat transfer.
14. Turbulence: physical description, eddy diffusivities, analogies.
15. Natural convection: general discussion and comparison with forced convection, Boussinesq approximation, mixed convection, natural convection over horizontal plates.
16. Draw a schematic diagram of a free convection boundary layer development over a vertical plate for the cases:
    (i) Plate temperature higher than the surrounding fluid temperature.
    (ii) Plate temperature lower than the surrounding fluid temperature
    Also show the velocity and temperature distributions.
17. Radiation: physical laws and main surface properties in radiation heat transfer. Black and gray surfaces in radiation. The view factor: assumptions, relations, examples.
18. A) Radiation shields. B) Media and radiating surfaces: participating medium; gaseous emission and absorption.