

MCL348: THERMAL MANAGEMENT OF ELECTRONICS

(3-0-0)

Course objectives:

The objective of this course is to introduce Working principles, modelling, and design of thermal management systems for electronics, such as heat sinks, heat pipes, microchannel heat exchangers, thermoelectric devices, and surface finishes. Hardware for thermal management of electronics will be discussed for various applications, including consumer electronics, defence, and space applications.

Syllabus

- Overview of thermal management of electronics: packaging and cooling technologies, trends and challenges.
- Heat sinks: heat transfer in extended surfaces, natural and forced convection, modeling and types of heat sinks. Contact resistance and role of thermal interface materials.
- Heat pipes and two-phase systems: physical working principles of different types of heat pipes, wick-based heat pipes, grooved heat pipes, micro heat pipes, looped heat pipes, mechanically pumped loops
- Steady state modelling of two-phase heat transfer in various heat pipes; introduction to design of heat pipes Microchannel heat exchangers: single phase and two-phase heat transfer, boiling regimes, effects of wettability.
- Radiative heat transfer: thermal surface finishes, multilayer insulation, radiators, cooling of spacecraft electronics. Thermoelectric devices: Peltier, Seebeck and Thomson effects, thermoelectric figure of merit.
- Characterisation techniques: measurement techniques for temperature, velocity, pressure, heat flux, and thermal properties.
- Case studies for thermal management of electronics in different fields, including consumer, defense, and spacecraft electronics.

Textbooks and References:

1. Y. Shabany, Heat Transfer: Thermal Management of Electronics, CRC Press, 2009.
2. K. Azar, Thermal measurements in electronics cooling, CRC Press, 1997
3. S. Kakac, H. Yuncu, K. Hijikata, Cooling of Electronic Systems, Kluwer Academic Publishers.
4. D. Reay, P. Kew, R. McGlen, Heat Pipes: Theory, Design and Applications.
5. ButterworthHeinemann, 2014. J. Sargent, Thermal Management Handbook: For Electronic Assemblies, McGraw Hill Professional, 1998.
6. Lian-Tuu Yeh and R. C. Chu, Thermal Management of Microelectronic Equipment, ASME Press, 2002.
7. D. Gilmore, Spacecraft Thermal Control Handbook, The Aerospace Corporation, 2002.