Indian Institute of Technology, Kanpur

Proposal for a New Course (Inter Departmental Course with AE, SEE, ME)

A) Course No: IDC/AE6##/SEE6##/ME6## or IDC/AE7##/SEE7##/ME7## Graduate Level Course, open to final year UGs

B) Course Title: Thermal Management of Electronics

C) Per Week Lectures: 3 (L), Tutorial: 0, Laboratory: 0 (P), Additional Hours: 0 (A)

Credits (3*L+2*T+P+A): 9 Duration of Course: Full Semester

D) Proposing Department/IDP: Aerospace Engineering
Other Departments/IDPs which may be interested in the proposed course: EE, MSE
Other faculty members interested in teaching the proposed course:

E) Proposing Instructor(s): Prof. Vaibhav Arghode (AE and SEE), Prof. Jishnu Bhattacharya (ME), Prof. Rakesh Kumar (AE)
[Late Prof. Sameer Khandekar (ME) originally drafted this course proposal]

F) Course Description:

A) Objectives: The objective of this course is to expose the graduate students with the nuances of thermal management of electronics. This suggested lecture plan covers a variety of essential and contemporary topics, and exposure to academic as well as industrial research topics in the art. After completing this course, the students should be able to appreciate, understand, analyse and design thermal management solutions based on the need and different constraints posed by the specific requirement. Accordingly, the objectives are as following:

- To establish fundamental understanding of heat transfer in electronic equipment.
- To be able to select a suitable cooling process for electronic components and systems.
- To increase the capabilities of graduate students in design and analysis of cooling of electronic packages.

B) Contents (*preferably in the form of 5 to 10 broad titles)*:

S.No.	Broad Title	Topics	No. of Lectures
1.	**Introduction**	Introduction and significance, power dissipation in electronics circuits, interconnects, high frequency losses, electronic packaging	4
2.	**Heat Transfer Fundamentals**	Basics of heat transfer: conduction, convection, radiation, boiling and condensation, electronics cooling, thermal resistance and heat flow paths in packages	4
3.	**Thermal Interface Materials**	Contact resistance, thermal interface materials (TIMs): greases, pads, phase change materials, TIM selection and performance	4
4.	**Introduction to Cooling Techniques**	Air cooling, liquid cooling and cold plates, microchannel heat sinks, heat sink design and analysis	6
5.	**Introduction to Two-Phase Cooling**	Heat pipes: principle and applications, vapor chambers, thermosyphons and capillary pumped loops, immersion cooling	6
6.	**Power Electronics Thermal Challenges**	Cooling strategies for power electronics, jet and spray cooling in power electronics, high heat flux cooling	4

7.	**System-Level Thermal Management**	Case studies: thermal management in data centers, automotive electronics, electric vehicle motors, batteries, solar photovoltaics, avionics	8
8.	**Emerging Trends and Future Directions**	Advanced packaging and integration, microscale and nanoscale thermal management, eco-friendly cooling solutions	4

C) Pre-requisites, if any (*examples: a- PSO201A, or b- PSO201A or equivalent*):
Undergraduate course in Thermodynamics and Heat Transfer (ESO201/SEE604, AE608/ME341/SEE601 or equivalent)

D) Short summary for including in the Courses of Study Booklet

Introduction to Thermal Management of Electronics, electronic packaging, power dissipation in electronic circuits, heat transfer, thermal interface materials, various cooling techniques, air cooling, liquid cooling, cold plates, microchannels, two-phase active and passive cooling, heat pipes, thermosyphons, immersion cooling, power electronics cooling, jet and spray cooling, automotive and battery cooling, data center thermal management, microscale and nanoscale cooling

G) Recommended books:

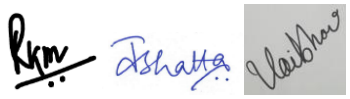
Textbooks:

1. Thermal Management of Electronics by Y. Shabany, CRC Press, 2010.
2. Thermal Management of Microelectronic Equipment by L. T. Yeh, R. C. Chu, ASME Press, 2002.
3. Thermal Design of Electronic Equipment by Ralph Remsburg, CRC Press, 2001.

Reference Books:

1. Cooling Techniques for Electronic Equipment by D. Steinberg, WILEY, 1991.
2. Liquid Vapor Phase-Change Phenomena by V. P. Carey, CRC Press, 2020.
3. Heat Pipe Science and Technology by A. Faghri, Taylor and Francis, 1995.
4. Introduction to Heat Pipes by Bud Peterson, WILY, 1994.
5. Handbook of Thermal Engineering by R. P. Chhabra, CRC Press, 2018.
6. Fundamentals of Microsystems Packaging by R. R. Tummala, McGraw Hill, 2001.
7. Heat Transfer and Fluid Flow in Minichannels and Microchannels by S. Kandlikar, S. Garimella, D. Li, S. Colin, M. King, Elsevier, 2014.
8. Energy Efficient Thermal Management of Data Centers by Y. Joshi, P. Kumar, Springer, 2012.
9. Fundamentals of Heat and Mass Transfer by F. P. Incropera, D. P., Dewitt, T. L. Bergman, A. S. Lavine, WILEY, 2013.

H) Any other remarks: The course will be open to final year UG students



Dated: August 12, 2025 Proposers:_____

Dated: DUGC/DPGC Convener:_____

The course is approved / not approved

Chairman, SUGC / SPGC

Dated:_____