Indian Institute of Technology, Kanpur
Proposal for a New Course

1. **Course No**: ME XXX

2. **Course Title**: Thermal Management of Electronic Systems

3. **Per Week Lectures**: 3 (L), Tutorial: 0 (T), Laboratory: 0 (P), Additional Hours [0-2]: 0 (A), Credits (3*L+2*T+P+A): 9
   Duration of Course: Full Semester / ~~Modular~~

4. **Proposing Department/IDP**: Mechanical Engineering

   Other Departments/IDPs which may be interested in the proposed course: Department of Sustainable Energy Engineering & Department of Aerospace Engineering.

   Other faculty members interested in teaching the proposed course: Prof. Vasudevan R. Iyer (ME)

5. **Proposing Instructor(s)**: Umesh Madanan (ME)

6. **Course Description**:

A) **Objectives**: This course will introduce working principles, modeling, and design of thermal management systems for electronics, such as heat sinks, heat pipes/thermosiphons/vapor chambers, microchannel heat exchangers, and thermoelectric devices. The course will also cover hardware for thermal management of various electronic systems, including consumer electronics, defence, and space applications. Upon completion of this course, students will be able to analyze and design thermal management solutions for electronic systems. This course will present students with practical and theoretical problems that will help them develop the quantitative skills required to model, evaluate, and optimize heat transfer in electronic devices and systems.

B) **Contents**:

S. No.	Broad Title	Topics	No. of 50-mins Lectures
1.	Introduction	Overview of thermal management of electronics: packaging and cooling technologies, trends and challenges	4
2.	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	6
3.	Heat pipes & two-phase systems	Physical working principles of different types of heat pipes, types of heat pipes (wick-based heat pipes, grooved heat pipes, micro heat pipes, looped heat pipes, mechanically pumped loops, immersion cooling)	6

4.	Modeling	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	5
5.	Radiative heat transfer	Thermal surface finishes, multilayer insulation, radiators, cooling of spacecraft electronics, thermoelectric devices (Peltier, Seebeck and Thomson effects), thermoelectric figure of merit	6
6.	Characterization techniques	Measurement techniques for temperature, velocity, pressure, heat flux, and thermal properties	5
7.	Case studies	Thermal management of electronics in different fields, including consumer, defense, and spacecraft electronics; techniques such as jet impingement and ion-trap cooling; reliability and failure modes.	6

C) **Pre-requisites, if any**: UG Fluid Mechanics (ME231) and Heat and Mass Transfer (ME341)

D) **Short summary for including in the Courses of Study booklet**: The course is designed for students interested in thermal engineering, especially as they apply to cooling of electronics. The course will provide an overview of the state-of-the-art of packaging and cooling challenges in electronics industry. Following this, various thermal management strategies will be introduced, before advancing to modeling of the same, where students will be exposed to measurement techniques for capturing various thermal/momentum transport parameters. Finally, the course will conclude with case studies on thermal management of electronic systems in different fields.

7. **Recommended books**:

Textbooks:

1. Y. Shabany, Heat Transfer: Thermal Management of Electronics (1st Edition, **eBook ISBN**: **9780429092220**, CRC Press, 2009)

Reference Books:

1. Thermal measurements in electronics cooling by *K. Azar* (1st Edition, **ISBN-10**: **0849332796**, **ISBN-13**: **9780849332791**, CRC Press, 1997)
2. Cooling of Electronic Systems *S. Kakaç, H. Yüncü, and K. Hijikata* (1st Edition, **ISBN-10**: **0792327365**, **ISBN-13**: **9780792327363**, Kluwer Academic Publishers)

3. Heat Pipes: Theory, Design and Applications by *D. Reay, P. Kew, and R. McGlen* (6th Edition, **ISBN-10**: **0080982665**, **ISBN-13**: **9780080982663**, Butterworth-Heinemann, 2014)
4. Thermal Management Handbook: For Electronic Assemblies by *J. Sergent* (1st Edition, **ISBN-10**: **0070266999**, **ISBN-13**: **9780070266995**, McGraw Hill Professional, 1998)
5. Thermal Management of Microelectronic Equipment by *Lian-Tuu Yeh and R. C. Chu* (1st Edition, **ISBN-10**: **0791800741**, **ISBN-13**: **9780791800744**, ASME Press, 2002)
6. Spacecraft Thermal Control Handbook by *D. Gilmore* (2nd Edition, **ISBN-10**: **188498911X**, **ISBN-13**: **9781884989117**, The Aerospace Corporation, 2002)

8. **Any other remarks**: N/A

Dated: 14.05.2026 **Proposer**: Umesh Madanan

Dated: _____ **DUGC/DPGC Convener**: _____

The course is approved / not approved

Chairman, SUGC/SPGC
Dated:_____