

THERMAL MANAGEMENT OF ELECTRONIC SYSTEMS
OPEN ELECTIVE-I

Course Code	23ME2504	Year	III	Semester	I
Course Category	Open Elective-I	Branch	Mechanical	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	NIL
Continuous Internal Evaluation:	30	Semester End Evaluation:	70	Total Marks:	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	BTL
CO1	Understand the basics of heat transfer and analyze heat transfer through fins	L2
CO2	Acquire the knowledge on Free and forced convective systems	L2
CO3	Understand the air cooling and single phase liquid cooling systems with case studies	L2
CO4	Demonstrate the concepts of Two phase cooling and heat pipes	L2
CO5	Understand thermo electric coolers, mini and micro channels	L2

Contribution of Course outcomes towards achievement of programme outcomes & Strength of correlations(High:3, Medium: 2, Low:1)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO-1	3	2	1	2	2	–	–	–	1	–	1	3	1
CO-2	3	3	2	2	2	–	–	–	1	–	1	3	1
CO-3	2	2	2	2	3	–	–	1	2	1	1	3	2
CO-4	2	2	3	3	3	–	–	1	2	1	2	3	2
CO-5	2	2	2	2	3	–	–	1	2	1	3	3	2

SYLLABUS		
Unit No.	Contents	Mapped CO
I	INTRODUCTION OF HEAT TRANSFER: Modes – Conduction, Convection and Radiation – Basic Laws – Applications of Heat Transfer. Basics of Conduction –Conduction equation – Thermal analogy – Lumped heat capacity analysis - Heat conduction with phase change - Thermal Resistance – Extended Surfaces – Uniform cross section fins – Fin efficiency – Selection and design of fins	CO1

II	FORCED AND FREE CONVECTION – Heat transfer coefficient - Parameters effecting heat transfer – Thermal Properties of fluids - Combined Modes. Radiation – Stefan- Boltzmann Law – Kirchoff’s law and Emissivity – Radiation between Black Isothermal Surfaces – Radiation between Grey Isothermal Surfaces – Extreme Climatic conditions - Radiation at normal ambient Temperature measurement and its Instrumentation.	CO1 CO2
III	PRINTED CIRCUIT BOARDS – Chip packaging – thermal Resistance – Board Cooling methods – Board thermal Analysis – Equivalent thermal Conductivity. Air Cooling – Fans – Heat transfer Enhancement – Air handling systems - Blowers SINGLE PHASE COOLING – Coolant Selection – Natural Convection – Forced Convection - Air Cooling - Convective cooling in Small systems – Forced cooling in medium and large systems – Liquid cooling in high power	CO1 CO3
IV	TWO PHASE COOLING – Direct Immersion Cooling – Basics of Pool Boiling – Enhancement of Pool Boiling – Flow Boiling. HEAT PIPES – Operation Principles – Useful Characteristics – Operating Limits and Temperatures – Operation Methods – Applications – Micro Heat Pipes.	CO1 CO4
V	THERMO ELECTRIC COOLERS: Basics theories – Thermo electric effect – Operation Principles. Phase change materials, Thermal Interface materials, Heat Spreaders and Heat Sinks – Working Principles Mini and Micro Channels. Use of nano fluids in electronic cooling.	CO1 CO5

Learning Resources	
TextBooks:	
<ol style="list-style-type: none"> 1. Thermal Analysis and Control of Electronic Equipment – Allan D. Kraus and Avram Bar Cohen, McGraw Hill, New York, NY, 1983. 2. Fundamentals of Microelectronics Packaging – Ed: Rao Tummala, McGraw Hill, New York, NY, 2001. 3. Packaging of Electronic Systems – James W. Dally, McGraw Hill, New York, NY, 1990. 	