<table>
<tr><td>Course Title</td><td>Thermal Management in Electric Vehicles</td><td>Course No
(to be assigned by Academic Cell)</td><td colspan="4">MEXXXX</td></tr>
<tr><td>Specialization</td><td>Faculty, Department of Mechanical</td><td>Structure (LTPC)</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Faculty Proposing the course</td><td>Dr.B.Raja</td><td>Status</td><td colspan="2">Core</td><td colspan="2">Elective ■</td></tr>
<tr><td>To be offered for</td><td>Mech Engg - B. Tech / M.Tech / PhD</td><td>Type</td><td colspan="2">New ■</td><td colspan="2">Modification</td></tr>
<tr><td>To take effect from</td><td>March 2023</td><td rowspan="2">Submitted for approval</td><td colspan="4" rowspan="2">_____Senate</td></tr>
<tr><td>Pre-requisite</td><td>Basic thermal fluid sciences</td></tr>
<tr><td>Learning Objectives</td><td colspan="6">• To introduce and emphasize the importance of thermal and fluid science aspects in thermal management of EVs
• To introduce design aspects of various active and passive methods of thermal management.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="6">At the end of the course the students will be able to understand the importance of thermal management with respect to EVs and design thermal management devices.</td></tr>
<tr><td>Contents of the course (With approximate break up of hours)</td><td colspan="6">Introduction – Need of thermal management, Battery thermal management, Thermal management in power electronic and electric motors – active and passive methods – Cooling and heating load estimation – Modes of heat generation - Thermal runaway (L6 + T2)

Thermal consideration in Chip Carrier, PCBs and Enclosure, Conduction Cooling, thermal resistance and resistance networks, conduction in chip carriers, conduction in PCB, heat frames and thermal conduction modules , synthetic jets. (L7 + T3)

Design application of natural and forced convection cooling in thermal management - Optimization of heat sinks and metal foams, fan selection; Liquid Cooled heat sinks - mini and micro channel heat exchangers, fluid selection; Jet impingement technique, Synthetic jets (L9 + T3)

Phase change methods - Heat pipes - principles, types, limits of heat pipe, thermal resistance, design procedure - application case studies and advancements; Loop heat pipes – immersion cooling - Phase change materials and selection (L10 + T3)

Design procedure of Peltier and Seebeck elements for thermal management - figure of merits, Current, Voltage and Power matching of thermoelectric modules , Radiation cooling, Emergency cooling modules- endothermic cooling and spot cooling techniques. (L10 + T3)</td></tr>
<tr><td>Text Books</td><td colspan="6">1. Dave S. Steinberg, Cooling Techniques for Electronic Equipment, 1991, John Wiley & Sons, Inc
2. HoSung Lee, Thermal Design: Heat Sinks, Thermoelectrics, Heat Pipes, Compact Heat Exchangers, and Solar Cells, 2011 John Wiley & Sons, Inc.</td></tr>
<tr><td>Reference Books</td><td colspan="6">1. W.M. Rohsenow, J.P Hartnett,C. Young, Heat Transfer Handbook, 1998, McGraw-Hill
2. Kaveh Azar, Thermal Measurements in Electronics Cooling, 1997, CRC Press
3. All Jamnia , Practical Guide to the Packaging of Electronics, 2002, CRC Press
4. Yunus A. Cengel and Michael Boles Thermodynamics: An Engineering Approach, 6th Ed, 2001, McGraw-Hill</td></tr>
</table>