MASTER OF TECHNOLOGY

Mechanical Engineering

Semester - II

Teaching Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
HS 5001	Research Methodology	2	0	0	2
ME 5005	Advanced Refrigeration & Air-Conditioning	3	1	2	5
ME 5013	Advanced Manufacturing Techniques-II for Industrial Infrastructure	3	0	3	5
	Open Elective - I	3	0	0	4
ME 50xx	Departmental Elective-II	3	0	0	4
	Total	**14**	**1**	**5**	**20**

Departmental Elective

Course Code	Course Name
ME 5014	Computational Fluid Dynamics and Heat Transfer

Mechanical Engineering

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<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">HS 5001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Research Methodology</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4"></td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introduction to engineering research: Denition, characteristics and types, basic research terminology, qualities of a researcher, research methods vs methodology, overview of engineering research methods, role of Information and Communication Technology (ICT) in research, research ethics, intellectual property rights and scholarly publishing.
Research formulation: Dening and formulating the research problem, selecting the problem, necessity of dening the problem, literature survey signicance in dening a problem, various sources, critical review, identifying gap areas from literature review and research databases, development of working hypothesis.
Research design and data analysis: Research design basic principles, need of research design, features of good design, important concepts relating to research design, observation and facts, laws and theories, method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis, hypothesis testing, generalization and interpretation.
Technical writing: Types (thesis, report, journal papers etc.), qualities, structure and components of good technical document, use of software tools (Word processing, LATEX, etc.), illustrations and tables, bibliography, referencing and footnotes. Oral presentation planning, software tools, creating and making effective presentation, use of visual aids, importance of effective communication.</td></tr>
</table>

VI	References Books:	1. Blessing, L.T.M., Chakrabarti, A., DRM: A Design Research Methodology, Springer, 2009, ISBN: 978-1-84882-586-4. 2. Chandra, S., Sharma, M.K., Research Methodology, Narosa Publishing House, 2013, ISBN: 978-81-8487-246-0. 3. Cohen, L., Manion, L., Morrison, K., Research Methods in Education, Routledge (Taylor and Francis Group), 2011, ISBN:978-0-415-58336-7. 4. Goddard, W., Melville, S., Research Methodology An Introduction, Juta and Company Ltd., 2004, ISBN: 978-0-702- 15660-1. 5. Kothari, C.R., Garg, G., Research Methodology Methods and Techniques, New Age International, 2014, ISBN: 978-81- 224-3623-5. 6. Kumar, R., Research Methodology A Step-by-Step Guide for Beginners, SAGE, 2011, ISBN: 978-1-84920-300-5. 7. Pandey, P., Pandey, M.M., Research Methodology Tools and Techniques, Bridge Centre, 2015, ISBN: 978-606-93502- 7-0. 8. Panneerselvam, R., Research Methodology, PHI Learning Pvt. Ltd., 2014, ISBN: 978-81-203-4946-9. 9. Rugg, G., Petre, M., A Gentle Guide to Research Methods, Open University Press, 2007, ISBN: 978-0-335-21927-8. 10. Singh, Y.K., Fundamentals of Research Methodology and Statistics, New Age International, 2006, ISBN: 978-81-224- 2418-8. 11. Walliman, N., Research Methods The Basics, Routledge (Taylor and Francis Group), 2011, ISBN:978-0-415-48994-2.

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<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 5005</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Advanced Refrigeration & Air-Conditioning</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>2</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4"></td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Review of Basic Refrigeration systems, Actual Vapour compression system, Multi stage compression, Multi evaporative systems, Vapor absorption system. Complete Vapour compression systems, Graphical method, analytical method, Newton-Raphson Method, optimal design of Evaporators, installation, Service and maintenance of VCRS. Alternative refrigerants, pros and cons of existing refrigerants, study of Montreal and Kyoto Protocols, Worldwide present scenario on alternative refrigerants, comparative study, and selection of refrigerant focusing on ODP & GWP. Trans-critical Vapour compression remigration, CO2 refrigeration system in trans-critical cycle. Challenges and opportunities in warm climatic conditions.
Component design issues. Analysis, modications and optimization of the system of the system. Cryogenics, Introduction to Cryogenics and its applications. Properties of cryogenic fluids. Properties of materials at cryogenic temperature. Gas-Liquefaction and Refrigeration Systems. Gas Separation. Cry coolers. Cryogenic Insulations. Vacuum Technology.
Refrigeration components, design and selection criteria of Compressors, Condensers, Expansion Valves, Types of expansion devices, sizing of capillary tube design.
Review of Air Conditioning systems, Psychometric processes, Psychometric processes, design of summer, winter and year round air conditioning. Design of cooling tower, Load Calculations, Cooling & Heating, Selection of air conditioning apparatus cooling and dehumidication. Design of Air conditioning apparatus, coil equipment, optimal design of cooling and dehumidifying coils, spray equipment, air washer and cooling tower design.
Transmission and distribution of air, duct design Transmission and distribution of air in rooms, centrifugal and axial flow fans and fan arrangements.
Refrigeration and air conditioning controls. Introduction to Cold Chain, Application of Refrigeration & Air Conditioning Systems, Food processing by refrigeration and storage, transportation refrigeration, Cooling and heating of foods, freeze drying and heat drying of foods. Current development, strategy and plan for cold chain in India and worldwide scenario.</td></tr>
</table>

VI	References Books:	1. Arora, C.P., Refrigeration and Air Conditioning, 3rd edition, McGraw Hill, New Delhi, 2012. 2. Roy J. Dossat, Principles of Refrigeration, 4th edition, Pearson Education Asia, 2009. 3. Gupta D K and Dasgupta M S, Book Chapter Transcritical CO2 Refrigeration System in Tropical Region: Challenges and Opportunities Handbook of Research on Advances and Applications in Refrigeration Systems and Technologies, IJI Global Publication USA 2016. 4. Stoecker, W.F. and Jones J. W., Refrigeration and Air Conditioning, McGraw Hill, New Delhi, 1986. 5. ASHRAE Hand book, Fundamentals, 2013. 6. Jones W.P., Air conditioning engineering, 5th Edition, Elsevier ButterworthHeinemann, 2001. 7. Manohar Prasad, Refrigeration and air-conditioning, Wiley Eastern Ltd, 1983. 8. Edward G. Pita, Air Conditioning Principles and Systems, 4th Ed., Pearson Education Asia, 2003.

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<tr><td>I</td><td>Course Code</td><td colspan="4">ME 5013</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Advanced Manufacturing Techniques-II for Industrial Infrastructure</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>3</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Manufacturing Processes, Basics of Automation, FEM and Statistics</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Joining Technology: This provides an advanced knowledge of the joining technology and the corresponding joining techniques and processes. Their industry specic application elds, with particular emphasis on the infrastructure sectors related to railways, aerospace, marine and automobile, would be explained. In addition, practical fundamentals with special emphasis on the nite element method correlating mechanical properties to HAZ will be discussed.
Automation: This is intended to impart knowledge in the eld of automation and robotics which is of interest to various manufacturing industries. Special focus would be on the robot as it is one of the key element of exible automation and production engineering. Fundamental non-robot components and machines that are important for the implementation of automated production systems shall also be discussed.
Machining Technology: This is proposed to provide detailed insight into machining processes as it is the most important precondition to understand their principle working mechanisms and hence to use this knowledge for their planning and optimization. Automation of the cutting force measurement, surface roughness measurement and tool wear measurement, are in the focus of this module. Emphasis would be on the problems related to companies in the HVM sector (e.g. automotive, aerospace, defence, medical engineering) where at least 25% of the process time for components arises from machining.
Laboratory Work: The laboratory work strictly incorporates experimental research. The laboratory work is performed in groups. Before the laboratory, the experiments need to be prepared. This means that each student has to possess an adequate knowledge of the theoretical foundations and practical implementation of the experiment.
Scientic Project Work: The Scientic Project includes a study related homework in a team work format. Thereby, each student has to show his/her own preparation to evaluate their own performance. After the submission of the work, the results should be presented in the form of a presentation by each student.</td></tr>
<tr><td>VI</td><td>References Books:</td><td colspan="4">1. Material and Processes in Manufacturing, Paul De Garmo, J.T. Black, and Ronald A. Kohser, Prentice Hall of India Private Limited, 2001.
2. Nontraditional Manufacturing Processes, Benedict. G.F., Marcel Dekker Inc., 1987.
3. Modern Machining Processes, Pandey P. C. and Shan H. S., McGraw Hill Education, 1980.
4. Mechanical Metallurgy, George E Dieter, McGraw Hill Education.
5. Elsevier,Springer,and Wiley ebooks from http://iitram.ac.in/library/index.php/ecollection/ebooks</td></tr>
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<tr><td>I</td><td>Course Code</td><td colspan="4">ME 5014 (Department Elective)</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Computational Fluid Dynamics and Heat Transfer</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Fluid Mechanics and Heat Transfer Knowledge of Fortran, Matlab or C Programming is desirable</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Mathematical Description of the Physical Phenomena
-Governing equationsmass, momentum, energy, species, General form of the scalar transport equation, Elliptic, parabolic and hyperbolic equations, Behavior of the scalar transport equation with respect to these equation type
Discretization Methods
- Methods for deriving discretization equations-finite difference, finite volume and finite element method, Method for solving discretization equations, Consistency, stability and convergence Diffusion Equation
- 1D-2D steady diffusion, Source terms, non-linearity, Boundary conditions, interface diffusion coefficient, Under- relaxation, Solution of linear equations (preliminary),
Unsteady
diffusion, Explicit, Implicit and Crank-Nicolson scheme,
Two
dimensional conduction, Accuracy, stability and convergence revisited
Convection and Diffusion
- Steady one-dimensional convection and diffusion, Upwind, exponential, hybrid, power, QUICK scheme, Two-dimensional convection-diffusion, Accuracy of Upwind scheme; false diffusion and dispersion, Boundary conditions
Flow Field Calculation
- Incompressibility issues and pressure-velocity coupling, Primitive variable versus other methods, Vorticity-stream function formulation, Staggered grid, SIMPLE family of algorithms
Multiphase problems
Modelling of multiphase problems: enthalpy method, volume of fluid (VOF) and Level Set Methods.
Introduction to turbulence modeling
Projects /Exercises
Solving simplified problems: formulation, discretization with coarse grids, applying appropriate boundary and initial conditions.
Solving practical problems through software: writing user sub-routines; post-processing and interpretation of results.</td></tr>
<tr><td>VI</td><td>References Books:</td><td colspan="4">1. S. V. Patankar, "Numerical Heat Transfer and Fluid Flow," Hemisphere Publishing Corporation, 1980.
2. D. A. Anderson, J. C. Tannehill, and R. H. Pletcher, "Computational Fluid Mechanics and Heat Transfer," Hemisphere Publishing Corporation, 1984.
3. J. H. Ferziger and M. Peric, "Computational Methods for Fluid Dynamics", Second Edition, Springer, Berlin, 1999.
4. H. K. Versteeg and W. Malalasekera, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method",</td></tr>
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