LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING
(An Autonomous Institution since 2010)
Approved by AICTE, New Delhi and Permanently Affiliated to JNTUK, Kakinada
L.B. Reddy Nagar, Mylavaram, NTR District, Andhra Pradesh - 521230

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE HANDOUT

PART-A

Name of Course Instructor : Dr. K Appa Rao (T053)
Course Name & Code : 23ME17
L-T-P Structure : 3-1-0 Credits : 3
Program/Sem/Sec : B.Tech., Mech Engg., VI-Sem., A.Y: 2025-26

PRE-REQUISITE: Thermodynamics, Thermal Engineering

COURSE EDUCATIONAL OBJECTIVES (CEOs):

To learn the physical mechanisms on modes of heat transfer, laws of governing equations in heat transfer and applications, steady and unsteady state heat transfer applications and the significance of Non-Dimensional Numbers.

COURSE OUTCOMES (COs): At the end of the course, the student will be able to

CO1	Understand the basic heat transfer principles, mechanisms and its practical relevance in Planes, cylinders and spherical components. **(Understanding-L2)**
CO2	Apply the laws of governing equations to solve the steady and unsteady state one dimensional heat transfer problems. **(Applying-L3)**
CO3	Solve free and forced convection problems related to external and internal flows using empirical correlations. **(Applying-L3)**
CO4	Compute the heat transfer in boiling, condensation and radiation thermal systems. **(Applying-L3)**
CO5	Compare the LMTD, NTU parameters in different heat exchangers for engineering applications using the data handbook. **(Analyzing-L4).**

COURSE ARTICULATION MATRIX (Correlation between COs, POs & PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	-	-	-	-	-	-	3	2	-	1
CO2	3	2	2	3	-	-	-	-	-	-	-	3	3	-	-
CO3	3	2	2	2	-	-	-	-	-	-	-	3	3	-	-
CO4	3	2	2	1	-	-	-	-	-	-	-	3	3	-	2
CO5	2	3	2	3	-	-	-	3	-	-	-	3	2	-	3

Note: Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**
1- Slight (Low), **2 –** Moderate (Medium), **3 -** Substantial (High).

TEXT BOOKS:

T1 R.C.Sachdeva - Fundamentals of Engineering Heat and Mass Transfer -New Age Science Publishers, 3rd Edition, 2009.
T2 Yunus. A. Cengel, Heat & Mass Transfer-A Practical Approach – Tata McGraw Hill, 4thEdition, 2012.
T3 J.P. Holman and S. Bhattacharyya, "Heat Transfer," McGraw Hill, 2017.

REFERENCE BOOKS:

R1 M.Necati Ozisik, Heat Transfer- A basic Approach, 4th Edition, McGraw-Hill Book Company, 1985.

R2 F.P. Incropera, and D.P. Dewitt, "Fundamentals of Heat and Mass Transfer," John Wiley, 2019.

R3 P.K.Nag, Heat and Mass Transfer- TMH 2nd Edition, 2007.

R4 C.P.Kothandaraman and Subramanian, Heat and Mass Transfer, New Age International Publications 7th Edition 2010.

R5 Dr.D.S.Kumar, "Heat and Mass Transfer", S.K.Kataria and Sons, 9th Edition, 2015, Publisher of Engineering and Computer works

Data Hand Book:

1. C.P. Kothandaraman and Subramanian, Heat and Mass Transfer Data Book, New Age International Publications, 10th Edition, Reprint 2012

NOTE: Heat and Mass Transfer Data Hand Book by C.P. Kothandaraman and Subramanian- New Age Publications is to be allowed in Examination.

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I: INTRODUCTION, ONE- DIMENSIONAL STEADY STATE CONDUCTION

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction to Course and Course Outcomes (COs) and POs articulation matrix.	1	01-12-2025		TLM1	
2.	Introduction of five Units importance	1	02-12-2025		TLM1	
3.	Introduction to heat transfer and its applications, Basic Modes of Heat Transfer	1	02-12-2025		TLM1 TLM2 TLM5	
4.	Numerical problems on Modes of Heat Transfer	1	03-12-2025		TLM5	
5.	Basic laws of Heat Transfer-Steady, Unsteady and Periodic Heat Transfer	1	06-12-2025		TLM1 TLM4	
6.	General heat conduction equation in Cartesian coordinate system and its simplifications.	1	08-12-2025		TLM1	
7.	Fourier's law of heat conduction; Thermal conductivity.	1	09-12-2025		TLM1 TLM2	
8.	Numerical problems on plane wall, composite plane wall. **- Tutorial -I**	1	09-12-2025		TLM1	
9.	General heat conduction equation in cylindrical coordinate system and its simplifications.	1	10-12-2025		TLM1	
10.	Numerical problems on cylinder and composite cylinder.	1	15-12-2025		TLM1	
11.	General heat conduction equation in spherical coordinate system and its simplifications.	1	16-12-2025		TLM1 TLM2	
12.	Numerical problems on sphere and composite sphere- **- Tutorial -2**	1	16-12-2025		TLM1	
13.	Heat conduction through plane wall and cylinder with constant thermal conductivity– Numerical Problems. **Tutorial -2**	1	17-12-2025		TLM1 TLM2	
14.	Electrical analogy, thermal resistance, and overall heat transfer coefficient.	1	20-12-2025		TLM1 TLM2 TLM5	
15.	Numerical Problems on thermal resistance and overall heat transfer coefficient	1	22-12-2025		TLM1 TLM2	
16.	Heat transfer through composite slab and cylinder, Numerical Problems. **Tutorial-3**	1	23-12-2025		TLM1 TLM2 TLM3	
17.	Critical radius of insulation for cylinder, Sphere and Applications.	1	23-12-2025		TLM1 TLM2	
18.	Numerical Problems on critical radius of insulation	1	24-12-2025		TLM1 TLM2	
No. of classes required to complete UNIT-I: 18				No. of classes taken:		

UNIT-II: ONE DIMENSIONAL STEADY AND TRANSIENT STATE HEAT CONDUCTION:

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Derivation on heat flow through a plane wall, cylinder with variable thermal conductivity.	1	27-12-2025		TLM1	
2.	Numerical problems on variable thermal conductivity – plane wall and cylinder **- Tutorial-4**	1	29-12-2025		TLM1 TLM2	
3.	Derivation on Uniform Internal heat generation in slabs	1	29-12-2025		TLM1	

4.	Numerical Problems on Uniform Internal heat generation in slabs.	1	30-12-2025		TLM1	
5.	Numerical Problems on Uniform Internal heat generation in cylinders.	1	31-12-2025		TLM1 TLM2	
6.	Extended surfaces - Classification	1	03-01-2026		TLM1	
7.	and their applications; Thermal analysis of long Fins	1	05-01-2026		TLM1 TLM4	
8.	Thermal analysis of short fins with insulated tip.	1	06-01-2026		TLM1 TLM2	
9.	Numerical Problems on long and short fins. **- Tutorial-5**	1	06-01-2026		TLM1	
10.	Fin efficiency and effectiveness	1	07-01-2026		TLM1	
11.	Problems on Fin efficiency and effectiveness	1	10-01-2026		TLM1	
12.	Systems with negligible internal Resistance (Lumped Heat Analysis), Significance of Biot and Fourier Numbers	1	19-01-2026		TLM1 TLM2	
13.	Numerical Problems, Heisler chart solutions	1	20-01-2026		TLM1 TLM2	
14.	**Tutorial-6**	1	20-01-2026		TLM1 TLM2	
15.	Revision – Unit-1	1	21-01-2026		TLM1	
16.	Revision – Unit -II	1	24-01-2026		TLM1	
No. of classes required to complete UNIT-II: 18				No. of classes taken:		

UNIT-III: CONVECTION – FORCED AND NATURAL CONVECTION

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction, applications – convective heat transfer coefficient	1	02-02-2026		TLM1 TLM2	
2.	Significance of Non-Dimensional numbers-The boundary layer concept	1	03-02-2026		TLM1 TLM2	
3.	The velocity and thermal boundary layer -Theory	1	03-02-2026		TLM1 TLM2	
4.	Numerical Problems on boundary layers.	1	04-02-2026		TLM1 TLM2	
5.	Numerical Problems on boundary layers.	1	07-02-2026		TLM1	
6.	Forced convection analysis in external flows (Flow over a Flat Plate): Laminar and turbulent flows.	1	09-02-2026		TLM1 TLM2	
7.	External flow over a flat plate – Laminar	1	10-02-2026		TLM1 TLM2	
8.	External flow over a flat plate – Turbulent	1	10-02-2026		TLM1 TLM2	
9.	Internal flow through pipes. **– Laminar condition Tutorial -7**	1	11-02-2026		TLM1	
10.	Internal flow through circular pipe) **turbulent condition.**	1	16-02-2026		TLM1 TLM2	
11.	Entry length and fully developed flow	1	17-02-2026		TLM1 TLM2	
12.	Reynolds Colburn Analogy	1	17-02-2026			
13.	Natural convection: Development of Hydrodynamic and thermal boundary layer along vertical plate.	1	18-02-2026		TLM1 TLM2 TLM4	
14.	Development of Hydrodynamic and thermal boundary layer along horizontal plate,	1	21-02-2026		TLM1 TLM2	
15.	Forced convection in Vertical and horizontal plates	1	23-02-2026		TLM1	
16.	Numerical Problems **Tutorial -8**	1	24-02-2026		TLM3	

17.	Numerical Problems	1	24-02-2026		TLM1	
No. of classes required to complete UNIT-III:11				No. of classes taken:		

UNIT-IV: BOILING AND CONDENSATION, THERMAL RADIATION

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction to boiling heat transfer and applications, Pool Boiling, Different regimes of boiling; Critical heat flux.	1	24-02-2026		TLM1, TLM2	
2.	Numerical problems on nucleate boiling, Critical heat flux conditions.	1	25-02-2026		TLM1, TLM2 TLM5	
3.	Condensation: Film wise and drop wise condensation, Laminar film wise condensation on Vertical plate	1	28-02-2026		TLM1, TLM2	
4.	Numerical Problems - **Tutorial-9**	1	02-03-2026		TLM3	
5.	Introduction and applications of Thermal Radiation, Emissive Power, Absorption, Reflection and Transmission and	1	03-03-2026		TLM1,	
6.	Definitions related to radiation, Concept of black and non-black bodies , Laws of black body radiation	1	03-03-2026		TLM1,	
7.	Emissivity, Kirchhoff's law, Shape Factors	1	04-03-2026		TLM1,	
8.	Radiation heat exchange between two black isothermal surfaces, Nonblack infinite parallel plates;	2	07-03-2026		TLM1,	
9.	Numerical Problems - **Tutorial-12**	1	09-03-2026		TLM1,	
No. of classes required to complete UNIT-IV:10				No. of classes taken:		

UNIT-V: HEAT EXCHANGERS

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction-Classification of heat exchangers - Flow arrangement, Temperature distribution,	1	10-03-2026		TLM1, TLM2 TLM6	
2.	Applications of Heat Exchangers	1	10-03-2026		TLM1, TLM2	
3.	Overall heat transfer coefficient- Fouling factor	1	11-03-2026		TLM1, TLM2	
4.	Derivation on LMTD method of Heat exchanger analysis-	1	14-03-2026		TLM1, TLM2 TLM4	
5.	Parallel flow, Numerical Problems	1	16-03-2026		TLM1,	
6.	Derivation on LMTD method of Heat exchanger analysis- Counter flow,	1	17-03-2026		TLM1, TLM2, TLM3	
7.	Numerical Problems – Counter flow HE – **Tutorial 10**	1	17-03-2026		TLM1,	
8.	Correction factor for LMTD for use with Multi pass and Cross flow Heat Exchangers	1	18-03-2026		TLM1, TLM2	
9.	Derivation - Effectiveness - NTU method of Heat Exchanger Analysis – parallel flow arrangement - Applications	1	21-03-2026		TLM3	

10.	Effectiveness - NTU method of Heat Exchanger Analysis – parallel flow arrangement problems	1	23-03-2026		TLM1,	
11.	Counter flow - Effectiveness - NTU method of Heat Exchanger Analysis- Applications of Heat Exchangers	1	24-03-2026		TLM1, TLM5	
12.	Cross flow - Effectiveness - NTU method of Heat Exchanger Analysis- Applications of Heat Exchangers-	1	24-03-2026		TLM1,	
13.	**Tutorial-11**	1	25-03-2026		TLM3	
No. of classes required to complete UNIT-V: 13				No. of classes taken:		

S.No.	Revision and recap of the Contents	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	First two units	1	28-03-2026		TLM5,6	
2.	Units III,IV and V	1	30-03-2026 31-03-2026		TLM5,6	

S.No.	Content Beyond the Syllabus	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
3.	Buckingham Pi Theorem – Forced convection	1	01-04-2026		TLM2	
4.	Buckingham Pi Theorem – Natural convection	1	04-04-2026		TLM2	

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

PART-C

EVALUATION PROCESS (R20 Regulations):

Evaluation Task	Marks
Assignment- Cycle I	A1=5
I-Mid Examination (Units-I,II)	M1=15
I-Quiz Examination (Units-I,II)	Q1=10
Assignment- Cycle - II	A3=5
II-Mid Examination (Unit-III, IV & V)	M2=15
II-Quiz Examination (Unit-III, IV & V)	Q2=10
Mid Marks =80% of Max (M1, M2) +20% of Min (M1, M2)	M=15
Quiz Marks =80% of Max (Q1, Q2) +20% of Min(Q1, Q2)	B=10
Cumulative Internal Examination (CIE): A+B+M	30
Semester End Examination (SEE)	70
Total Marks = CIE + SEE	100

PART-D

PROGRAMME OUTCOMES (POs):

PO 1	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO 2	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO 3	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO 4	Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO 5	Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO 6	The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO 7	Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO 8	Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO 9	Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO 10	Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO 11	Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAMME SPECIFC OUTCOMES (PSOs):

PSO 1	To apply the principles of thermal sciences to design and develop various thermal systems.
PSO 2	To apply the principles of manufacturing technology, scientific management towards improvement of quality and optimization of engineering systems in the design, analysis and manufacturability of products.
PSO 3	To apply the basic principles of mechanical engineering design for evaluation of performance of various systems relating to transmission of motion and power, conservation of energy and other process equipment.

Course Coordinator	Module Coordinator	HOD
(Dr. K. Appa Rao)	(Dr. P.Vijay Kumar)	(Dr.M.B.S.S.Reddy)

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DEPARTMENT OF MECHANICAL ENGINEERING

COURSE HANDOUT

PART-A

Name of Course Instructor: Dr.A. DHANUNJAY KUMAR
Course Name & Code : ARTIFICIAL INTELLIGENCE& MACHINE LEARNING(23ME18)
L-T-P Structure :3-0-0 **Credits:** 3
Program/Sem/Sec : B.Tech/VI/A **A.Y.:** 2025-26
PREREQUISITE: Engineering physics

Course Objective: This course introduces the fundamental concepts of Artificial Intelligence (AI), including knowledge representation and reasoning techniques. It covers key machine learning paradigms such as supervised and unsupervised learning, Bayesian algorithms, and neural networks. Students will also gain insights into genetic algorithms, machine learning analytics, and emerging deep learning techniques

COURSE OUTCOMES (COs): At the end of the course, student will be able to

CO1	Describe the fundamental concepts and techniques of artificial intelligence. **(Understanding – L2)**
CO2	Apply the principles of supervised learning methods to solve classification and regression problems. **(Applying – L3)**
CO3	Apply unsupervised learning techniques and Bayesian algorithms for data clustering and probabilistic inference. **(Applying – L3)**
CO4	Apply neural networks and genetic algorithms to solve optimization and pattern recognition problems. **(Applying – L3)**
CO5	Apply machine learning analytics and implement basic deep learning techniques for realworld applications. **(Applying – L3)**

COURSE ARTICULATION MATRIX (Correlation between COs, POs & PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2					1		2	1	2	2
CO2	2	3	2	2	3				1	1		2	1	3	2
CO3	2	3	2	3	3				1	1		2	1	3	2
CO4	2	3	3	2	3				1	1	1	2	1	3	3
CO5	2	3	3	2	3	1			1	1	1	3	1	3	3

TEXTBOOKS:

T1	Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2/e, Pearson Education, 2010
T2	Tom M. Mitchell, Machine Learning, McGraw Hill, 2013.
T3	Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.
T4	Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.

REFERENCE BOOKS:

R1	Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
R2	Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012
R3	Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
R4	Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018
R5	Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
R6	Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)

ONLINE RESOURCES:

https://www.tpointtech.com/artificial-intelligence-ai

https://www.geeksforgeeks.org/

PART-B

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I: INTRODUCTION TO ARTIFICIAL INTELLIGENCE (AI)

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction	1	02/12/2025		TLM2	
2.	Definition of Artificial Intelligence, Evolution	1	04/12/2025		TLM2	
3.	Need, and applications in real world	1	05/12/2025		TLM2	
4.	Intelligent Agents, Agents and Environments	1	09/12/2025		TLM2	
5.	Types of agents	1	11/12/2025		TLM2	
6.	the nature of environment, structure of agents	1	12/12/2025		TLM2	
7.	Logical Agents: Knowledge-based agents	1	16/12/2025		TLM2	
8.	the Wumpus world, logic	1	18/12/2025		TLM1	
9.	Patterns in Propositional Logic, Inference in First-Order Logic	1	19/12/2025		TLM1	
10.	Propositional vs first order inference, unification.	1	23/12/2025		TLM2	
No. of classes required to complete UNIT-I: 10				**No. of classes taken:**		

UNIT-II: INTRODUCTION TO MAHCINE LEARNING (ML)

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
11.	Definition, Evolution, Need, applications of ML in industry and real-world	1	26/12/2025		TLM2	
12.	regression and classification problems	1	30/12/2025		TLM1	
13.	performance metrics	1	02/01/2026		TLM1	
14.	differences between supervised and unsupervised learning paradigms	1	06/01/2026		TLM2	
15.	bias, variance, overfitting and under fitting	1	08/01/2026		TLM1	

16.	Linear regression, logistic regression	1	09/01/2026		TLM2	
17.	Distance-based methods, Nearest-Neighbors	1	20/01/2026		TLM1	
18.	Decision Trees, Support Vector Machines	1	22/01/2026		TLM2	
19.	Nonlinearity and Kernel Methods	1	23/01/2026		TLM2	
No. of classes required to complete UNIT-II: 9				**No. of classes taken:**		

UNIT-III: UNSUPERVISED LEARNING

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
20.	Clustering, K-means	1	03/02/2026		TLM2	
21.	Dimensionality Reduction,	1	05/02/2026		TLM2	
22.	PCA and Kernel	1	06/02/2026		TLM2	
23.	Bayes theorem, concept learning	1	10/02/2026		TLM1	
24.	maximum likelihood of normal, binomial	1	12/02/2026		TLM1	
25.	exponential, and Poisson distributions,	1	13/02/2026		TLM1	
26.	Minimum description length principle	1	17/02/2026		TLM1	
27.	implementation, applications	1	19/02/2026		TLM2	
28.	Naïve Bayes Classifier	1	20/02/2026		TLM2	
29.	Instance-based Learning- K-Nearest neighbour learning	1	24/02/2026		TLM2	
No. of classes required to complete UNIT-III: 10				**No. of classes taken:**		

UNIT-IV: NEURAL NETWORKS AND GENTIC ALGORITHMS

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
30.	Neural network representation, problems	1	26/02/2026		TLM2	
31.	perceptron, multilayer networks and backpropagation	1	27/02/2026		TLM2	
32.	steepest descent method	1	03/03/2026		TLM1	
33.	Convolutional neural networks and their applications	1	26/02/2026		TLM2	
34.	Recurrent Neural Networks and their applications	1	06/03/2026		TLM2	
35.	Local vs Global optima	1	10/03/2026		TLM2	
36.	Genetic algorithms- binary coded GA	1	12/03/2026		TLM1	
37.	operators, convergence criteria	1	13/03/2026		TLM1	
No. of classes required to complete UNIT-IV: 9				**No. of classes taken:**		

UNIT-V: DEEP LEARNING AND ML ALGORITHM ANALYTICS

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
38.	Deep generative models	1	17/03/2026		TLM2	
39.	Deep Boltzmann Machines	1	19/03/2026		TLM2	
40.	Deep auto-encoders	1	20/03/2026		TLM2	
41.	Applications of Deep Networks	1	24/03/2026		TLM2	
42.	Evaluating Machine Learning algorithms	1	26/03/2026		TLM2	
43.	Model, Selection	1	27/03/2026		TLM2	
44.	Ensemble Methods - Boosting	1	31/03/2026		TLM2	
45.	Bagging	1	02/04/2026		TLM2	
46.	Random Forests	1	03/04/2026		TLM2	
No. of classes required to complete UNIT-V: 10				**No. of classes taken:**		

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

PART-C

VALUATION PROCESS (R23 Regulation):

Evaluation Task	Marks
Assignment-I (Units-I, II)	A1=5
I-Descriptive Examination (Units-I, II)	M1=15
I-Quiz Examination (Units-I, II)	Q1=10
Assignment-II (Unit-III , IV & V)	A2=5
II- Descriptive Examination (UNIT-III , IV & V)	M2=15
II-Quiz Examination (UNIT-III, IV & V)	Q2=10
Mid Marks =80% of Max ((M1+Q1+A1), (M2+Q2+A2)) + 20% of Min ((M1+Q1+A1), (M2+Q2+A2))	M=30
Cumulative Internal Examination (CIE): M	30
Semester End Examination (SEE)	70
Total Marks = CIE + SEE	100

PART-D

PROGRAMME OUTCOMES (POs):

PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	Use research-based knowledge and research methods including design of experiments, analysis

	and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO 1	To apply the principles of thermal sciences to design and develop various thermal systems.
PSO 2	To apply the principles of manufacturing technology, scientific management towards improvement of quality and optimization of engineering systems in the design, analysis and manufacturability of products.
PSO 3	To apply the basic principles of mechanical engineering design or evaluation of performance of various systems relating to transmission of motion and power, conservation of energy and other process equipment.

Title	**Course Instructor**	**Course Coordinator**	**Module Coordinator**	**Head of the Department**
Name of the Faculty	**Dr.A. DHANUNJAY KUMAR**	**Dr.A. DHANUNJAY KUMAR**	**J. SUBBA REDDY**	**Dr.M.B.S.S REDDY**
Signature				

LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING

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L.B. REDDY NAGAR, MYLAVARAM, KRISHNA DIST., A.P.-521 230.
Phone: 08659-222933, Fax: 08659-222931

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE HANDOUT

PART-A

Name of Course Instructor: Dr.B.Sudheer Kumar
Course Name & Code : FINITE ELEMENT METHODS & 23ME19
L-T-P Structure : **2-1-0** **Credits:** 3
Program/Sem/Sec : B.Tech/VI **A.Y.:** 2025-26

PREREQUISITE: Mechanics of Solids, Heat Transfer

COURSE EDUCATIONAL OBJECTIVES (CEOs): The main objective of this course is to understand the principles of finite elements and to develop finite models for engineering applications.

COURSE OUTCOMES (COs): At the end of the course, the student will be able to

CO1	Formulate the equilibrium equations for solving static engineering problems**.(Applying-L3)**
CO2	Analyze structural behavior of plane truss elements.**(Analyzing-L4)**
CO3	Compute the characteristics of flexural elements under different loading conditions. **(Applying-L3)**
CO4	Analyzing 2-D structures with iso-parametric elements along with Axi-symmetric problems**.(Analyzing-L4)**
CO5	Apply finite element techniques to solve thermal problems and dynamic analysis of bar and beam elements. **(Applying-L3)**

COURSE ARTICULATION MATRIX (Correlation between COs, POs & PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	-	3	-	-	-	-	3	2	-	-	3
CO2	2	2	2	3	3	3	-	-	-	-	3	2	-	-	3
CO3	2	3	2	2	3	3	-	-	-	-	3	2	-	-	3
CO4	3	2	2	3	-	3	-	-	-	-	3	2	-	3	
CO5	2	2	2	3	3	3	-	-	-	-	3	2	-	3	3
1 - Low **2 –**Medium **3 -** High															

BOS APPROVED TEXT BOOKS:

T1. 1. Chandraputla, Ashok and Belegundu, Introduction to Finite Elements in Engineering, 6th edition, Prentice-Hall,2014.

T2. S.S Rao, The Finite Element Methods in Engineering 6th edition, B.H.Pergamon.2013

BOS APPROVED REFERENCE BOOKS:

R1 SS Bhavikatti, Finite Element Analysis, New Age International Publishers 3rd edition 2005.

R2 JN. Reddy, An introduction to Finite Element Method, 3rd edition, Mc Graw Hill, 2011.

R3. George R. Buchanan and R. Rudra Moorthy, Finite Element Analysis, Tata Mc Graw Hill,2006.

PART-B

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I: **ONE DIMENSIONAL PROBLEM**

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1	Introduction to Finite Element Method	1	01-12-2025		TLM1	
2.	Equilibrium equations in elasticity, Stresses in typical element, Stresses & equilibrium	1	02-12-2025		TLM1	
3.	Strain displacement relations, Stress strainrelations	1	04-12-2025		TLM1	
4.	Plane stress and plane strain problems. Potential energy and equilibrium method	1	06-12-2025		TLM1	
5.	Finite Element Formulation from governing differential equations. One dimensional Problem,FE Modeling	1	08-12-2025		TLM1	
6.	Shape functions & Coordinates of shape functions	1	09-12-2025		TLM1	
7.	Assembly of GSM & Load vector, Finite element equations and treatment of boundary conditions	1	11-12-2025		TLM1	
8.	Problems- 1D Bar	1	13-12-2025		TLM1	
9.	Problems- 1D Bar		15-12-2025			
10.	**Tutorial-I**	1	16-12-2025		TLM3	
11.	Thermal induced stresses and strains	1	18-12-2025		TLM1	
12.	Problems- 1D Composite Bar	1	20-12-2025		TLM1	
13.	Problems- 1D Composite Bar		22-12-2025			
14.	**Tutorial-II**	1	23-12-2025		TLM3	
15.	Assignment/Quiz-1	1	27-12-2025		TLM1	
No. of classes required to complete UNIT-I:				**No. of classes taken:**		

UNIT-II: ANALYSIS OF TRUSS

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actuall Date of Completion	Teaching Learning Methods	HOD Sign Weekly
16.	Analysis of Truss: Truss elements	1	29-12-2025		TLM1	
17.	Coordinates and Shape Functions, assembly of global stiffness matrix and load vector	1	30-12-2025		TLM1	
18.	Finite element equations and treatment of boundary condition	1	03-01-2026		TLM1	
19.	Stress, strain and support reaction calculations	1	05-01-2026		TLM1	
20.	Problems-	1	06-01-2026		TLM1	
21.	Problems-	1	08-01-2026		TLM1	
22.	**Tutorial-III**	1	10-01-2026		TLM3	
23.	Problems-	1	19-01-2026		TLM1	
24.	Problems-	1	20-01-2026		TLM1	
25.	**Tutorial-IV**	1	22-01-2026		TLM3	
26.	Assignment/Quiz-2	1	24-01-2026		TLM1	
No. of classes required to complete UNIT-II:				**No. of classes taken:**		

MID-I EXAMS 26-01-2026 TO 31-01-2026

UNIT-III: ANALYSIS OF BEAMS

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
27.	Analysis of Beams: Beam elements	1	02-02-2026		TLM1	
28.	Types loading, DOF, Boundary conditions	1	03-02-2026		TLM1	
29.	Hermite shape functions	1	05-02-2026		TLM1	
30.	Stiffness matrix for two node DOF per node	1	07-02-2026		TLM1	
31.	Problems- on Simply Supported Beam with point Load	1	09-02-2026		TLM1	
32.	Problems- on Simply Supported Beam with UDL	1	10-02-2026		TLM1	
33.	**Tutorial-III**	1	12-02-2026		TLM3	
34.	Problems- on Cantilever Beam with UDL	1	14-02-2026		TLM1	
35.	Problems- on Cantilever Beam with UDL	1	16-02-2026		TLM1	
36.	**Tutorial-IV**	1	17-02-2026		TLM3	
37.	Assignment/Quiz-2	1	19-02-2026		TLM1	
No. of classes required to complete UNIT-II:				**No. of classes taken:**		

UNIT-IV: CONSTANT STRAIN TRAINGLE & AXISYMMETRIC LOADING

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
38.	Introduction to constant strain triangle	1	21-02-2026		TLM1	
39.	2-D elements (CST) &BC, Jacobian, Shape functions, Area of triangles	1	23-02-2026		TLM1	
40.	Problems- CST Element(Traction force & Body Force	1	24-02-2026		TLM1	
41.	**Tutorial-V**	1	26-02-2026		TLM3	
42.	Axisymmetric solids & loading with triangular elements	1	28-02-2026		TLM1	
43.	2-D four nodded isoparametric elements, Jacobian, shape functions,	1	02-03-2026		TLM1	
44.	Problems	1	03-03-2026		TLM1	
45.	**Tutorial-VI**	1	05-03-2026		TLM3	
46.	Problems- On Axisymmetric Loading on quadratic Elements	1	07-03-2026		TLM1	
47.	Problems- On Axisymmetric Loading on quadratic Elements	1	09-03-2026		TLM1	
48.	**Assignment& Quiz-III**	1	10-03-2026		TLM3	
No. of classes required to complete UNIT-IV:				**No. of classes taken:**		

UNIT-V: STUDY STATE HEAT TRANSFER ANALYSIS & DYNAMIC ANALYSIS

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
49.	One dimensional analysis of HT problems	1	12-03-2026		TLM1	
50.	Conductivity matrix, boundary conditions	1	14-03-2026		TLM1	
51.	Problems-On Composite wall	1	16-03-2026		TLM1	
52.	**Tutorial-VII**	1	17-03-2026		TLM3	
53.	1-D analysis of a fin, Conductivity matrix boundary conditions.	1	19-03-2026		TLM1	
54.	Problems-On Fin with Circular Cross section	1	21-03-2026		TLM1	
55.	Introduction-Dynamic analysis	1	23-03-2026		TLM1	
56.	Hamilton Principle for Eigen value and Eigen Vector	1	24-03-2026		TLM1	
57.	Consistent Mass Matrix Equation for Bar and Beam Element	1	28-03-2026		TLM1	

58.	Problems - Eigen values and Eigen vectors for a stepped bar	1	30-03-2026		TLM1	
59.	Problems - Eigen values and Eigen vectors for a stepped bar	1	31-03-2026		TLM1	
60.	Problems - Eigen values and Eigen vectors for a Beams	1	02-04-2026		TLM1	
61.	Problems - Eigen values and Eigen vectors for a Beams	1	04-04-2026		TLM3	
62.	**Beyond Syllabus -** Evaluation of Eigen values and Eigen vectors for a beam with different loads	1	04-04-2026		TLM3	
MID-II EXAMS 06-04-2026 TO 11-04-2026						
No. of classes required to complete UNIT-V: 13				**No. of classes taken:**		

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

PART-C

EVALUATION PROCESS (R17 Regulation):

Evaluation Task	**Marks**
Assignment-I (Units-I, II & UNIT-III (Half of the Syllabus))	A1=5
I-Descriptive Examination (Units-I, II & UNIT-III (Half of the Syllabus))	M1=15
I-Quiz Examination (Units-I, II & UNIT-III (Half of the Syllabus))	Q1=10
Assignment-II (Unit-III (Remaining Half of the Syllabus), IV & V)	A2=5
II- Descriptive Examination (UNIT-III (Remaining Half of the Syllabus), IV & V)	M2=15
II-Quiz Examination (UNIT-III (Remaining Half of the Syllabus), IV & V)	Q2=10
Mid Marks =80% of Max ((M1+Q1+A1), (M2+Q2+A2)) + 20% of Min ((M1+Q1+A1), (M2+Q2+A2))	M=30
Cumulative Internal Examination (CIE): M	30
Semester End Examination (SEE)	70
Total Marks = CIE + SEE	100

PART-D

PROGRAMME OUTCOMES (POs):

PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering Problems.

PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, Natural sciences, and engineering sciences.
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance**: Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO 1	To apply the principles of thermal sciences to design and develop various thermal systems.
PSO 2	To apply the principles of manufacturing technology, scientific management towards Improvement of quality and optimization of engineering systems in the design, analysis and manufacturability of products.

PSO 3	To apply the basic principles of mechanical engineering design for evaluation of performance of various systems relating to transmission of motion and power, conservation of energy and other process equipment.

Title	**Course Instructor**	**Course Coordinator**	**Module Coordinator**	**Head of the Department**
Name of the Faculty	**Dr.B.Sudheer Kumar**	**Dr.B.Sudheer Kumar**	**Dr.B.Sudheer Kumar**	**Dr. M.B.S.Sreekara Reddy**
Signature				

LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING
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L.B. Reddy Nagar, Mylavaram, NTR District, Andhra Pradesh - 521230

COURSE HANDOUT
PART-A

Course Instructor: Dr.Murahari Kolli		**Course Coordinator**	**:** Dr.Murahari Kolli
Course Name : Advanced Machining Processes		**Course Name**	: 23ME21
L-T-P Structure: 3-0-0		**Credits**	: 3
Program	**:** B.Tech., III Year VI-Sem.,	**Department**	**:** Mechanical
Section	: Mech (A)	**A.Y**	: 2025-26

PRE-REQUISITE: MANUFACTURING SCIENCE, MACHINE TOOLS

COURSE OBJECTIVE: The main objective of this course is to familiarize with unconventional machining processes and rapid prototyping.

COURSE OUTCOMES (CO)

CO1	Apply the principles of advanced machining processes such as AJM, EDM, ECM, and laser-based methods to select suitable techniques for specific applications**.(Applying – L3)**
CO2	Demonstrate the working principles and applications of various additive manufacturing techniques, including rapid tooling methods.(**Applying – L3)**
CO3	Apply surface treatment techniques and laser-based material processing methods for coating and modification of engineering surfaces.(**Applying – L3)**
CO4	Utilize advanced coating processes such as PVD, CVD, thermal spraying, and nanomaterial synthesis techniques for surface enhancement.(**Applying – L3)**
CO5	Describe the fabrication steps involved in microelectronic device manufacturing, including lithography, film deposition, and packaging.(**Understanding – L2)**

COURSE ARTICULATION MATRIX (Correlation between COs&POs,PSOs):

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2		3									2	
CO2	3	2	3		3									3	
CO3	3	2	3		3								2	3	
CO4	3	2	3		3								2	3	
CO5	3	2	3		3									3	

Note: Enter Correlation Levels**: 1-**Slight (Low), **2 -** Moderate (Medium), **3 -** Substantial (High).

BOS APPROVED TEXT BOOKS:

T1 Manufacturing Engineering and TechnologyIKalpakijian / Adisson Wesley, 1995.
T2 Process and Materials of Manufacturing / R. A. Lindburg / 1th edition, PHI 1990.
T3 Pandey P.C. and Shah H.S, Modern Machining Process / TMH.

BOS APPROVED REFERENCE BOOKS:

R1 Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van Nostrand Renihold,
R2 MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH
R3 Advanced Machining Processes / V.K.Jain / Allied Publications.
R4 Introduction to Manufacturing Processes / John A ScheyIMcGraw Hill.
R5 Introduction to Nanoscience and Nano Technology/ Chattopadhyay K.K/A.N.Banerjee/ PHI Learning
R6 M.K.Singh, Unconventional Manufacturing Processes / New age international.

PART-B

COURSE DELIVERY PLAN (LESSON PLAN)

UNIT-I: INTRODUCTION TO ADVANCED MACHINING PROCESSES

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
1.	Introduction of aMP and Course Co's and Po's	1	02.12.2025		TLM1/TLM2	CO1	T1/R1	
2.	Introduction Need for AMP, Classification of AMP	1	03.12.2025		TLM1/TLM2	CO1	T1/R1	
3.	AJM, Principle, working, advantages, limitations, Applications	1	05.12.2025		TLM1/TLM2	CO1	T1/R1	
4.	WJM, Principle, working, advantages, limitations, Applications	1	09.12.2025		TLM1/TLM2	CO1	T1/R1	
5.	Wire-EDM, Principle, working, advantages, limitations, Applications	1	10.12.2025		TLM1/TLM2	CO1	T1/R1	
6.	ECM, Principle, working, advantages, limitations, Applications	1	12.12.2025		TLM1/TLM2	CO1	T1/R1	
7.	LBM, Principle, working, advantages, limitations, Applications	1	16.12.2025		TLM3/TLM6	CO1	T1/R1	
8.	EBM, Principle, working, advantages, limitations, Applications	1	17.12.2025		TLM1/TLM2	CO1	T1/R1	
9.	PAM Principle, working, advantages, limitations, Applications	1	19.12.2025		TLM1/TLM2	CO1	T1/R1	
No. of classes required to complete UNIT-I		09			No. of classes taken:			

UNIT-II: ADDITIVE MANUFACTURING

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
10.	ADDITIVE MANUFACTURING Introduction, Need types	1	23.12.2025		TLM1/TLM2	CO1	T1/R1	
11.	Stereo Lithography, Working Principles,	1	24.12.2025		TLM1/TLM2	CO1	T1/R1	
12.	Applications and Limitations,	1	26.12.2025		TLM1/TLM2	CO1	T1/R1	
13.	LENS, Working Principles,	1	30.12.2025		TLM1/TLM2	CO1	T1/R1	

14.	Applications and Limitations,	1	31.12.2025		TLM1/TLM2	CO1		
15.	LOM, Working Principles,	1	02.01.2026		TLM1/TLM2	CO2	T1/R1	
16.	Applications and Limitations,	1	06.01.2026		TLM1/TLM2	CO2	T1/R1	
17.	Laser Sintering, Working Principles,	1	07.01.2026		TLM1/TLM2	CO2	T1/R1	
18.	Applications and Limitations,	1	09.01.2026		TLM1/TLM2	CO2	T1/R1	
19.	Fused Deposition Method, Working Principles,	1	20.01.2026		TLM1/TLM2	CO2	T1/R1	
20.	Applications and Limitations,	1	21.01.2026		TLM1/TLM2	CO2	T1/R1	
21.	3DP Working Principles, Applications and Limitations,	1	23.01.2026		TLM1/TLM2	CO2	T1/R1	
No. of classes required to complete UNIT-II		12			No. of classes taken:			

UNIT-III: SURFACE TREATMENT AND PROCESSING OF CERAMICS

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome Cos	Text Book followed	HOD Sign Weekly
22.	SURFACE TREATMENT: Scope, Cleaners,	1	03.02.2026		TLM1/TLM2	CO3	T1/R1	
23.	Methods of cleaning,	1	04.02.2026		TLM1/TLM2	CO3	T1/R1	
24.	Surface coating types,	1	06.02.2026		TLM1/TLM2	CO3	T1/R1	
25.	Electro forming,	1	10.02.2026		TLM1/TLM2	CO3	T1/R1	
26.	Chemical vapour deposition,	1	11.02.2026		TLM1/TLM2	CO3	T1/R1	
27.	Physical vapour deposition,	1	13.02.2026		TLM1/TLM2	CO3	T1/R1	
28.	thermal spraying methods,	1	17.02.2026		TLM1/TLM2	CO3	T1/R1	
29.	Ion implantation,	1	18.02.2026		TLM1/TLM2	CO3	T1/R1	
30.	diffusion coating,	1	20.02.2026		TLM1/TLM2	CO3	T1/R1	
31.	ceramic and organic methods of coating,	1	24.02.2026		TLM1/TLM2	CO3	T1/R1	
32.	Cladding methods.	1	25.02.2026		TLM1/TLM2	CO3	T1/R1	
33.	Industrial Applications of surface treatment	1	27.02.2026		TLM1/TLM2	CO3	T1/R1	
No. of classes required to complete UNIT-III		11			No. of classes taken:			

UNIT-IV: PROCESSING OF COMPOSITES AND NANOMATERIALS

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome Cos	Text Book followed	HOD Sign Weekly
34.	PROCESSING OF COMPOSITES: Composite Layers,	1	03.03.2026		TLM1/TLM2	CO4	T2/R3	

35.	Particulate and fiber reinforced composites,	1	04.03.2026		TLM1/TLM2	CO4	T2/R3	
36.	Elastomers, Reinforced plastics,	1	06.03.2026		TLM1/TLM2	CO4	T2/R3	
37.	processing methods for MMC	1	10.03.2026		TLM1/TLM2	CO4	T2/R3	
38.	CMC, Polymer matrix Composites.	1	11.03.2026		TLM1/TLM2	CO4	T2/R3	
39.	Top down Vs Bottom up techniques-Ball	1	13.03.2026		TLM1/TLM2	CO4	T2/R3	
40.	Lithography,	1	17.03.2026		TLM1/TLM2	CO4	T2/R3	
41.	Plasma Arc Discharge,	1	18.03.2026		TLM1/TLM2	CO4	T2/R3	
42.	Pulsed Laser Deposition,	1	20.03.2026		TLM1/TLM2	CO4	T2/R3	
43.	Sputtering, Sol-Gel	1	24.03.2026		TLM1/TLM2	CO4	T2/R3	
No. of classes required to complete UNIT-IV		10			No. of classes taken:			

UNIT-V: FABRICATION OF MICROELECTRONIC DEVICES

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome Cos	Text Book followed	HOD Sign Weekly
44.	Crystal growth and wafer preparation,	1	25.02.2026		TLM1/TLM2	CO5		
45.	Film Deposition, oxidation, lithography,	1	27.02.2026		TLM1/TLM2	CO5		
46.	bonding and packaging,	1	31.03.2026		TLM1/TLM2	CO5		
47.	reliability and yield,	1	01.04.2026		TLM1/TLM2	CO5		
48.	Printed Circuit boards,	1	03.04.2026		TLM1/TLM2	CO5		
No. of classes required to complete UNIT-V		05			No. of classes taken:			

Contents beyond the Syllabus

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly

Teaching Learning Methods					
TLM1	Chalk and Talk	**TLM4**	Problem Solving	**TLM7**	Seminars or GD
TLM2	PPT	**TLM5**	Programming	**TLM8**	Lab Demo
TLM3	Tutorial	**TLM6**	Assignment or Quiz	**TLM9**	Case Study

Academic Calendar:

Commencement of IV Semester Classwork	**09-12-2024**		
Description	**From**	**To**	**Weeks**

I Phase of Instructions	01-12-2025	24-01-2026	7 W
I Mid Examinations	26-01-2026	31-01-2026	1 W
II Phase of Instructions	02-02-2026	04-04-2026	9 W
II Mid Examinations	06-04-2026	11-04-2026	1 W
Preparation and Practicals	13-04-2026	18-04-2026	1 W
Semester End Examinations	20-04-2026	02-05-2026	2 W
Internship	04-05-2026	27-06-2027	8 W
Commencement of V Semester Classwork	**29-06-2026**		

EVALUATION PROCESS:

Evaluation Task	**Marks**
Assignment–I (Unit-I,II)	A1=5
I-Mid Examination (Unit-I,II)	M1=15
Quiz-Q1 (Unit-I,II)	Q1-10
Assignment – II (III,IV & V)	A2=5
II-Mid Examination (III,IV & V)	M2=20
Quiz-Q2 (III,IV & V)	Q2-10
Mid Marks: B=80% of Max((M1,Q1+A1), (M2,Q2+A2), +20% of Min(M2,Q2+A2), (M1,Q1+,	M=30
Cumulative Internal Examination : M	30
Semester End Examinations (SEE)	70
Total Marks: 30+70	100

PART-C

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1	To build a professional career and pursue higher studies with sound knowledge in Mathematics, Science and Mechanical Engineering.
PEO 2	To inculcate strong ethical values and leadership qualities for graduates to become successful in multidisciplinary activities.
PEO 3	To develop inquisitiveness towards good communication and lifelong learning.

PROGRAMME OUTCOMES (POs):

PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO 1	To apply the principles of thermal sciences to design and develop various thermal systems.
PSO 2	To apply the principles of manufacturing technology, scientific management towards improvement of quality and optimization of engineering systems in the design, analysis and manufacturability of products.
PSO 3	To apply the basic principles of mechanical engineering design for evaluation of performance of various systems relating to transmission of motion and power, conservation of energy and other process equipment.

Signature				
Name of the Faculty	Dr.K.Murahari	Dr.K.Murahari	Mr.J.Subba Reddy	Dr.M.B.S.S Reddy
Designation	**Course Instructors**	**Course Coordinator**	**Module Coordinator**	**HoD**

LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING
(An Autonomous Institution since 2010)
Approved by AICTE, New Delhi and Permanently Affiliated to JNTUK, Kakinada
L.B. Reddy Nagar, Mylavaram, NTR District, Andhra Pradesh - 521230

DEPARTMENT OF MECHANICAL ENGINEERING

RENEWABLE ENERGY TECHNOLOGIES - COURSE HANDOUT

PART-A

Name of Course Instructor : Dr. P Ravindra Kumar (T507)
Course Name & Code : 23ME22
L-T-P Structure : 3-0-0 Credits : 3
Program/Sem/Sec : B.Tech., Mech Engg., VI-Sem., A.Y: 2025-26

PRE-REQUISITE: Thermodynamics, Thermal Engineering

COURSE EDUCATIONAL OBJECTIVES (CEOs):

To provide the insights on different renewable energy sources, potential, salient features and utilization of solar, wind, geothermal, ocean thermal energy, bio energy and fuel cell systems.

COURSE OUTCOMES (COs): At the end of the course, the student will be able to

CO1	Demonstrate the importance, the impact of solar radiation. **(Understanding-L2)**
CO2	Understand the principles of solar PV modules and storage in PV systems. **(Understanding-L2)**
CO3	Discuss solar energy storage systems and their applications. **(Understanding-L2)**
CO4	Describe power extraction from wind and bio-mass. **(Understanding-L2)**
CO5	Illustrate the working of geothermal, ocean energy and fuel cells. **(Understanding-L2)**

COURSE ARTICULATION MATRIX (Correlation between COs, POs & PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	2	2	-	2
CO5	3	3	-	-	-	-	-	-	-	-	-	2	2	-	1

Note: Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**
1- Slight (Low), **2 –** Moderate (Medium), **3 -** Substantial (High).

TEXT BOOKS:

1. Renewable Energy Technologies -Ramesh & Kumar /Narosa
2. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH
3. Non-conventional Energy Source- G.D Roy/Standard Publishers.

REFERENCES:

1. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006.
2. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd
3. Non-conventional Energy Source- G S Sawhney- PHI, New Delhi, 2012.

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I: SOLAR RADIATION

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Course Outcomes – Program Outcomes, Program Specific Outcomes, CO-PO/PSO mapping, Introduction	1	02-12-2025		TLM1 TLM2	
2.	Introduction and importance of this course	1	03-12-2025		TLM1 TLM2	
3.	Role and potential of new and renewable sources,	1	05-12-2025		TLM1 TLM2	
4.	Solar energy option, Environmental impact of solar power	1	09-12-2025		TLM1 TLM2	
5.	Structure of the sun, the solar constant,	1	10-12-2025		TLM1 TLM2	
6.	Sun-earth relationships	1	12-12-2025		TLM1 TLM2	
7.	Coordinate systems and coordinates of the sun	1	16-12-2025		TLM1 TLM2	
8.	Extraterrestrial and terrestrial solar radiation	1	17-12-2025		TLM1 TLM2	
9.	Solar radiation on titled surface	1	19-12-2025		TLM1 TLM2	
10.	Instruments for measuring solar radiation and sun shine, solar radiation data.	2	23-12-2025 24-12-2025		TLM1 TLM2	
11.	Numerical Problems	1	26-12-2025		TLM1	
No. of classes required to complete UNIT-I: 12				No. of classes taken:		

UNIT-II: SOLAR PV MODULES AND PV SYSTEMS

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	PV Module Circuit Diagram, Module Structure	1	30-12-2025		TLM1 TLM2	
2.	Packing Density, Interconnections	1	31-12-2025		TLM1 TLM2	
3.	Mismatch and Temperature Effects, Electrical and Mechanical Insulation,	1	02-01-2026		TLM1 TLM2	
4.	Lifetime of PV Modules, Degradation and Failure	1	06-01-2026		TLM1 TLM2	
5.	PV Module Parameters, Efficiency of PV Module,	1	07-01-2026		TLM1 TLM2	
6.	Solar PV Systems.	1	09-01-2026		TLM1 TLM2	
7.	Battery Operation, Types of Batteries, Battery Parameters, Application	1	20-01-2026		TLM1 TLM2	
8.	Selection of Batteries for Solar PV System	1	21-01-2026		TLM1 TLM2	
9.	Numerical Problems	1	23-01-2026		TLM1	
No. of classes required to complete UNIT-II: 9				No. of classes taken:		

UNIT-III: SOLAR ENERGY COLLECTION &
SOLAR ENERGY STORAGE AND APPLICATIONS:

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Flat plate and concentrating collectors	1	03-02-2026		TLM1 TLM2	
2.	Classification of concentrating collectors, orientation.	2	04-02-2026 06-02-2026		TLM1 TLM2	
3.	Different methods, sensible, latent heat and stratified storage,	1	10-02-2026		TLM1 TLM2	
4.	Solar ponds, solar applications	1	11-02-2026		TLM1 TLM2	
5.	Solar heating/cooling technique	1	13-02-2026		TLM1 TLM2	
6.	Solar distillation and drying, solar cookers	1	16-02-2026		TLM1 TLM2	
7.	Central power tower concept and solar chimney	1	17-02-2026		TLM1 TLM2	
No. of classes required to complete UNIT-III:8				No. of classes taken:		

UNIT-IV: WIND ENERGY & BIO-MASS

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Wind energy Sources and potentials,	1	18-02-2026		TLM1 TLM2	
2.	Horizontal and vertical axis windmills	1	20-02-2026		TLM1 TLM2	
3.	Performance characteristics,	1	24-02-2026		TLM1 TLM2	
4.	Betz's criteria	1	25-02-2026		TLM1 TLM2	
5.	Types of winds, wind data measurement	1	27-02-2026		TLM1 TLM2	
6.	Principles of bio-conversion	1	03-03-2026		TLM1 TLM2	
7.	Anaerobic/aerobic digestion	1	04-03-2026		TLM1 TLM2	
8.	Types of bio-gas digesters,	2	06-03-2026		TLM1 TLM2	
9.	Gas yield, Gasifiers, applications	1	10-03-2026		TLM1 TLM2	
10.	Numerical Problems	1	11-03-2026		TLM1	
No. of classes required to complete UNIT-IV:11				No. of classes taken:		

UNIT-V: GEOTHERMAL, OCEAN AND GREEN ENERGY

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Origin, Applications, Types of Geothermal Resources Geothermal power generation, Relative Merits and Demerits.	1	13-03-2026		TLM1 TLM2	

2.	Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants Environmental Impacts, Challenges and applications.	1	17-03-2026		TLM1 TLM2	
3.	Introduction, Fuel cells-Applications, Classification, Different Types of Fuel Cells	1	18-03-2026		TLM1 TLM2	
4.	Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell	1	20-03-2026		TLM1 TLM2	
5.	MC Fuel Cell. Hydrogen- Zero energy Concepts.	1	16-03-2026		TLM1 TLM2	
6.	Benefits of hydrogen energy, hydrogen production technologies	1	24-03-2026		TLM1 TLM2	
7.	Hydrogen energy storage Applications of hydrogen energy, problem associated with hydrogen energy.	1	25-03-2026		TLM1 TLM2	
8.	Numerical Problems	1	27-03-2026		TLM1 TLM2	
No. of classes required to complete UNIT-V: 8				No. of classes taken:		

S.No.	Content Beyond the Syllabus	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Organic Rankine Cycle	1	03-04-2026		TLM2	

S.No.	Revision and recap of the Contents	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
2.	First two units	1	31-03-2026		TLM6	
3.	Units III,IV and V	1	01-04-2026		TLM6	

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

PART-C

EVALUATION PROCESS (R20 Regulations):

Evaluation Task	Marks
Assignment- Cycle I	A1=5
I-Mid Examination (Units-I,II)	M1=15
I-Quiz Examination (Units-I,II)	Q1=10
Assignment- Cycle - II	A3=5
II-Mid Examination (Unit-III, IV & V)	M2=15
II-Quiz Examination (Unit-III, IV & V)	Q2=10
Mid Marks =80% of Max (M1, M2) +20% of Min (M1, M2)	M=15
Quiz Marks =80% of Max (Q1, Q2) +20% of Min(Q1, Q2)	B=10
Cumulative Internal Examination (CIE): A+B+M	30
Semester End Examination (SEE)	70
Total Marks = CIE + SEE	100

PART-D

PROGRAMME OUTCOMES (POs):

PO 1	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO 2	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO 3	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO 4	Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO 5	Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO 6	The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO 7	Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO 8	Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO 9	Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO 10	Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO 11	Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAMME SPECIFC OUTCOMES (PSOs):

PSO 1	To apply the principles of thermal sciences to design and develop various thermal systems.
PSO 2	To apply the principles of manufacturing technology, scientific management towards improvement of quality and optimization of engineering systems in the design, analysis and manufacturability of products.
PSO 3	To apply the basic principles of mechanical engineering design for evaluation of performance of various systems relating to transmission of motion and power, conservation of energy and other process equipment.

Course Coordinator	Module Coordinator	HOD
(Dr. P Ravindra Kumar)	(Dr. P.Vijay Kumar)	(Dr.M.B.S.S.Reddy)

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DEPARTMENT OF MECHANICAL ENGINEERING
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L B Reddy Nagar, Mylavaram-521 230, Krishna District, Andhra Pradesh.

COURSE HANDOUT

PROGRAM : B.Tech., VI-Sem. ME

ACADEMIC YEAR : 2025-2026

COURSE NAME & CODE : Refrigeration and Air-Conditioning - 23ME27

L-T-P STRUCTURE : 2-1-0

COURSE CREDITS : 3

COURSE INSTRUCTOR : **Dr. V. DHANA RAJU**

COURSE COORDINATOR : **Dr. V. DHANA RAJU**

PRE-REQUISITE: Thermodynamics

COURSE OBJECTIVE: In a broader way, this course provides the simple understanding of refrigeration and air conditioning fundamentals. First, it covers the different refrigeration cycles and its analysis. Then the concepts of psychrometry and psychrometry processes used for air conditioning are imparted. Finally, the concepts of comfort air conditioning, cooling load design and its estimation are addressed.

COURSE OUTCOMES (COs)

CO1: Describe the basic concepts of refrigeration and its applications.
CO2: Evaluate the performance parameters of refrigeration systems.
CO3: Identify the desirable refrigerants and its use in various refrigeration systems.
CO4: Analyze the psychrometric properties and processes used in Air Conditioning systems.
CO5: Design of Air Conditioning systems for thermal comfort conditions.

COURSE ARTICULATION MATRIX (Correlation between COs&POs,PSOs):

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2		2	2					2	3		
CO2	3	3	3	2		2	2					2	3		
CO3	2	2	2	2		3	3					2	2		
CO4	3	3	2	2		2	2					2	2		
CO5	3	3	3	2		2	2					2	3		

Note: Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**
1- Slight(Low), **2 -** Moderate(Medium), **3 -** Substantial (High).

BOS APPROVED TEXT BOOKS:

T1 C. P. Arora. , Refrigeration and air conditioning - TMH, 2nd Edition, 2000.

T2 R. Dossat, Principles of Refrigeration - - Pearson 4th Edition 2001.

BOS APPROVED REFERENCE BOOKS:

R1 S. C. Arora, Domkundwar, A course in refrigeration and air conditioning-Dhanapat Rai& sons 5th Edition 1997.

R2 Wilbert F.Stoecker, Jerold W. J.Jones, MGH, 1986.

R3 Manohar Prasad, Refrigeration and Air conditioning, New Age international, 2003

COURSE DELIVERY PLAN (LESSON PLAN): Section-A

UNIT-I FUNDAMENTALS OF REFRIGERATION

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome Cos	Textbook followed	HOD Sign Weekly
1.	**Unit-1:** Introduction to R&AC	1	02-12-2025		TLM2	CO1	**T1**	
2.	Unit of refrigeration and COP	1	03-12-2025		TLM2	CO2	**T1**	
3.	Heat Engine, Refrigerator and Heat pump	1	04-12-2025		TLM2	CO1	**T1**	
4.	Types of Refrigeration systems	1	06-12-2025		TLM2	CO1	**T1**	
5.	Problems on refrigeration basics	1	09-12-2025		TLM2, TLM 4	CO2	**T1**	
6.	**Refrigerant:** Desirable characteristics of ideal refrigerant	1	10-12-2025		TLM2	CO3	**T1**	
7.	Classification of refrigerants- Desirable Properties-Nomenclature, Refrigerant Designation	1	11-12-2025		TLM 1	CO3	**T1**	
8.	Commonly used refrigerants, Alternate refrigerants, Green House effect& Global	1	16-12-2025		TLM 1	CO3	**T1**	
9.	**Air refrigeration system**: working on Reversed Carnot cycle	1	17-12-2025		TLM 1	CO1	**T1**	
10.	Air refrigeration system working on Bell Coleman cycle, Air refrigeration Problems	1	18-12-2025		TLM 1	CO1	**T1**	
11.	COP- Open and Dense air systems Problems	1	20-12-2025		TLM 1	CO2	**T1**	
12.	Tutorial-1	1	23-12-2025		TLM 1	CO2	**T1**	
No. of classes required to complete UNIT-I = 12			No. of classes taken:					

UNIT-II VAPOUR COMPRESSION REFRIGERATION SYSTEM & COMPONENTS

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome Cos	Text Book followed	HOD Sign Weekly
13	**Introduction to VCR system: VCR cycle**	1	24-12-2025		TLM 1	CO1	T1	
14	Simple vapour compression refrigeration cycle, COP	1	27-12-2025		TLM 1	CO1	T1	
15	Representation of cycle on T-S and p-h Charts	1	30-12-2025		TLM 1	CO1	T2	
16	VCR numerical problems	1	31-12-2025		TLM 1	CO2	T2	
17	Tutorial-2	1	01-01-2026		TLM 1	CO2	T2	
18	Effect of sub cooling and superheating,	1	03-01-2026		TLM 1	CO1	T2	
19	Effect of condenser and evaporator pressure, Actual VCR and theoretical VCR,	1	06-01-2026		TLM 1	CO1	T2	

20	**VCR-System Components**: Compressors -Classification-Working Principles	1	07-01-2026		TLM 1	CO1	**T2**	
21	Work expression for the reciprocating compressor	1	08-01-2026		TLM 1	CO1	**T2**	
22	Rotary compressors, Problems, Condensers – Classification-working principle,	1	13-01-2026		TLM 1	CO1	**R1**	
23	Evaporators-Classification-working principle,	1	20-01-2026		TLM 1	CO1	**R1**	
24	Expansion valve – Classification-working principle-	1	21-01-2026		TLM 1	CO1	**R1**	
No. of classes required to complete UNIT-II = 12			No. of classes taken:					

UNIT-III VAPOUR ABSORPTION, STEAM JET & NON-CONVENTIONAL REFRIGERATION SYSTEM

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome Cos	Text Book followed	HOD Sign Weekly
25	Introduction to VAR system and its working principle,	1	22-01-2026		TLM 1	CO1	**T2**	
26	Max. COP derivation for the VAR system and VAR problems	1	24-01-2026		TLM 1	CO2	**T2**	
I-Mid Exams :26.01.2026 to 31.01.2026								
27	Description and working of NH_3-Water system, Refrigerant-Absorbent solution requirements	1	03-02-2026		TLM 1	CO1	**T2**	
28	LiBr-Water (Two shell & Four shell) System,	1	04-02-2026		TLM 1	CO1	**T2**	
29	Principle of operation of Three fluid absorption systems, Salient features	1	05-02-2026		TLM 1	CO1	**T2**	
30	**Steam Jet Refrigeration System:** Working Principle, Basic Analysis- Applications	1	07-02-2026		TLM 1	CO1	**T2**	
31	. **Non-Conventional Refrigeration Systems:** Thermo electric refrigeration,	1	10-02-2026		TLM 1	CO1	**T2**	
32	Vortex tube refrigeration,	1	11-02-2026		TLM 1	CO1	**T2**	
33	Adiabatic Demagnetization refrigeration		12-02-2026		TLM 1	CO1	**T2**	
No. of classes required to complete UNIT-III = 09			No. of classes taken:					

UNIT-IV PSYCHROMETRY & HUMAN COMFORT

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome Cos	Text Book followed	HOD Sign Weekly
34	**Psychrometry**: Introduction,	1	17-02-2026		TLM 1	CO4	**T1**	
35	Psychometric properties and relations	1	18-02-2026		TLM 1	CO4	**T1**	

36	Psychometric problems	1	19-02-2026		TLM 1	CO4	**T1**	
37	Psychometric chart and its analysis,		21-02-2026		TLM 1	CO4	**T1**	
38	Psychometric processes and its analysis	1	24-02-2026		TLM 1	CO4	**T1**	
39	Psychometric processes and its analysis	1	25-02-2026		TLM 1	CO4	**T1**	
40	Sensible, Latent and Total heat,	1	26-02-2026		TLM 1	CO4	**T1**	
41	Sensible Heat Factor and Bypass Factor, Solving Problems	1	28-02-2026		TLM 1	CO4	**T1**	
42	**Human Comfort:** Thermodynamics of human body	1	03-03-2026		TLM 1	CO4	**T1**	
43	Factors affecting the human comfort and its analysis.	1	05-03-2026		TLM 1	CO4	**T1**	
44	Effective temperature – Comfort chart	1	07-03-2026		TLM 1	CO4	**T1**	
No. of classes required to complete UNIT-IV = 14			No. of classes taken:					

UNIT-V AIR CONDITIONING SYSTEMS AND DESIGN

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
45	**Introduction**: Air Conditioning Systems,	1	10-03-2026		TLM 1	CO5	**T1**	
46	Components of Air conditioning	1	11-03-2026		TLM 1	CO5	**T1**	
47	Classification of air conditioning system	1	12-03-2026		TLM 1	CO5	**T1**	
48	Central and Unitary systems, Winter and Year-round systems	1	17-03-2026		TLM 1	CO5	**T1**	
49	Cooling load estimation and its procedure	1	18-03-2026		TLM 1	CO5	**T1**	
50	Cooling load components	1	21-03-2026		TLM 1	CO5	**T1**	
51	Infiltration load, Design of Air Condition Systems,	1	24-03-2026		TLM 1	CO5	**T1**	
52	Bypass factor-circulated air with ADP, System with Ventilated and re-circulation,	1	25-03-2026		TLM 1	CO5	**T1**	
53	RSHF, GSHF and ESHF, Solving cooling load Problems	1	28-03-2026		TLM 1	CO5	**T1**	
54	Cooling load problems	1	31-03-2026		TLM 1	CO5	**T1**	
55	Revision	1	01-04-2026		TLM 1	CO5	**T1**	
No. of classes required to complete UNIT-V = 12			No. of classes taken:					

Contents beyond the Syllabus

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
54	Cryogenics	1	02-04-2026		TLM2	CO1	R3	
55	Ozone Protection refrigerants	1	04-04-2026		TLM2	CO3	R3	
II-Mid Exams :06.04.2026 to 11.04.2026								

Teaching Learning Methods					
TLM1	Chalk and Talk	**TLM4**	Problem Solving	**TLM7**	Seminars or GD
TLM2	PPT	**TLM5**	Programming	**TLM8**	Lab Demo
TLM3	Tutorial	**TLM6**	Assignment or Quiz	**TLM9**	Case Study

ACADEMIC CALENDER:

Commencement of Class work		24.06.2024	
I Phase of Instructions	01.12.2025	24.01.2025	8 Weeks
I Mid Examinations	26.01.2026	31.01.2026	1 Week
II Phase of Instructions	02.02.2026	04.04.2026	9Weeks
II Mid Examinations	06.04.2026	11.04.2026	1 Week
Preparation and Practical's	13.04.2026	18.04.2026	1 Week
Semester End Examinations	20.04.2026	02.05.2026	2 Weeks

PART-C

EVALUATION PROCESS (R 23Regulations):

Evaluation Task	Marks
Assignment-I (Units-I, II)	A1=5
I-Descriptive Examination (Units-I, II)	M1=15
I-Quiz, short answer questions (Units-I, II)	Q1=10
Assignment-II (Units-III IV & V)	A2=5
II- Descriptive Examination (UNIT-III, IV & V)	M2=15
II-Quiz short answer questions (UNIT-III ,IV & V)	Q2=10
Mid Marks =80% of Max ((M1+Q1+A1), (M2+Q2+A2)) + 20% of Min ((M1+Q1+A1), (M2+Q2+A2))	M=30
Cumulative Internal Examination (CIE):	30
Semester End Examination (SEE)	70
Total Marks = CIE + SEE	100

PART-D

PROGRAMME OUTCOMES (POs):

PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO 6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethic**s: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO 1	**Communication:** Design and develop modern communication technologies for building the inter disciplinary skills to meet current and future needs of industry.
PSO 2	**VLSI and Embedded Systems:** Design and Analyze Analog and Digital Electronic Circuits or systems and Implement real time applications in the field of VLSI and Embedded Systems using relevant tools
PSO 3	**Signal Processing:** Apply the Signal processing techniques to synthesize and realize the issues related to real time applications

Course Instructor	Course Coordinator	Module Coordinator	HOD
Dr.V.Dhana Raju	Dr.V.Dhana Raju	Dr. P.Vijay Kumar	Dr. M.B.S.Sreekara Reddy

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

COURSE HANDOUT

PART-A

Name of Course Instructor : Mr P.Rathnakar Kumar
Course Name & Code : Utilization of Electrical Energy & 23EE83
L-T-P Structure : 3-0-0 Credits : 3
Program/Sem/Sec : B.Tech, MECHANICAL., VI-Sem. A.Y : 2025-26
Pre-requisites : Basic Electrical Engineering

Course Educational Objective: This course enables the student to acquire knowledge on methods of Electric Heating and welding, different lighting schemes. It also introduces the concepts of Electric Drives for Industrial and traction system, and also different tariff methods.

COURSE OUTCOMES (COs): At the end of the course, students are able to

CO 1	Understand mechanism of electric heating and electric welding. **(Understand-L2)**
CO 2	Analyze performance of various lighting schemes. (Understand-L2)
CO 3	Analyze the performance of electric drive systems. (Understand-L2)
CO 4	Understand the different schemes of traction and its main components **(Understand-L2)**
CO5	Understand various tariff methods and power factor improvement techniques. (Understand-L2)

COURSE ARTICULATION MATRIX (Correlation between COs, POs & PSOs):

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO a	PSO b	PSO c
CO1	2	2	2												
CO2	2	2	2								2				
CO3	2	2	2												
CO4	2	2	2								2				
CO5	2	2	2								2				

Note: Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**
1- Slight (Low), **2** – Moderate (Medium), **3** - Substantial (High).

TEXT BOOKS:

T1: C.L.Wadhwa "Generation, Distribution and Utilization of Electrical energy, New Age International Publishers,3rd Edition,2015.

T2: N.V.Suryanarayana "Utilization of electric power including electric drives and electric traction, New age international publishers New Delhi,2nd edition 2014.

REFERENCE BOOKS:

1.V K Mehta & Rohit Mehta, "Principles of Power System", Revised Edition, S.Chand Publications, 2022.
2.A.Chakrabarthi, M.L.Soni, P.V.Gupta and U.S.Bhatnagar, "A Textbook on Power system Engineering", Dhanpat Rai Publishing Company (P) Ltd., 2008.

Part - B
COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I: ELECTRIC HEATING &WELDING

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction, CEO's &CO's	1	2-12-2025		TLM1	
2.	Advantages &applications of Electric heating	1	05-12-2025		TLM2	
3.	Classification of electric heating	1	06-12-2025		TLM2	
4.	Resistance heating, Arc heating	1	09-12-2025		TLM2	
5.	Induction heating, dielectric heating	1	12-12-2025		TLM2	
6.	Causes of failures of heating elements, Materials for heating elements	1	13-12-2025		TLM2	
7.	Requirement of good heating material	1	16-12-2025		TLM2	
8.	ARC Furnace	1	19-12-2025		TLM2, TLM4	
9.	Resistance welding: Spot welding, seam welding	1	20-12-2025		TLM2, TLM6	
10.	Arc welding, Comparison between AC and DC welding	1	23-12-2025		TLM2, TLM4	
No. of classes required to complete UNIT-I: 10					No. of classes taken:	

UNIT-II: ILLUMINATION ENGINEERING

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
11.	Introduction, Nature of light	1	26-12-2025		TLM1, TLM2	
12.	Laws of illumination	1	27-12-2025		TLM1	
13.	Laws of illumination	1	30-12-2025		TLM1	
14.	Lighting schemes, sources of light	1	02-01-2026		TLM2	
15.	Fluorescent Lamp, CFL and LED	1	03-01-2026		TLM1, TLM4	
16.	Sodium Vapor Lamp	1	06-01-2026		TLM1, TLM4	
17.	Neon lamps, Mercury vapor lamps	1	09-01-2026		TLM1, TLM2	

18.	Comparison between tungsten & fluorescent tubes	1	10-01-2026		TLM1, TLM2	
19.	Requirements of good lighting	1	17-01-2026		TLM1, TLM2	
20.	Street lighting, Assignment/Quiz	1	20-01-2026		TLM2, TLM6	
No. of classes required to complete UNIT-II: 10					No. of classes taken:	

UNIT-III: ELECTRIC DRIVES

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
21.	Introduction, Elements of drive, advantages	1	23-01-2026		TLM2	
22.	Factors affecting selection of motor,	1	24-01-2026		TLM2	
23.	Types of Electric drives	1	03-02-2026		TLM2	
24.	Types of loads	1	06-02-2026		TLM1, TLM2	
25.	Transient Characteristics of drives	1	07-02-2026		TLM1, TLM2	
26.	Steady state characteristics of drives	1	10-02-2026		TLM1, TLM2	
27.	Size of motor, Load Equalization	1	13-02-2026		TLM1,TLM2	
28.	Industrial applications	1	17-02-2026		TLM1,TLM2	
No. of classes required to complete UNIT-III: 08					No. of classes taken:	

UNIT-IV: ELECTRIC TRACTION

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
29.	Introduction	1	20-02-2026		TLM2	
30.	Requirement of an ideal traction system	1	21-02-2026		TLM2	
31.	Supply system for electric traction and track electrification	1	24-02-2026		TLM2	
32	Train movement	1	27-02-2026		TLM2	
33.	Mechanism of train movement, traction motors	1	28-02-2026		TLM2	
34.	Speed time curves for different services	1	03-03-2026		TLM1, TLM2	
35.	Trapezoidal speed time curves	1	06-03-2026		TLM1, TLM2	
36.	Quadrilateral speed time curves	1	07-03-2026		TLM1, TLM2	
37.	Problems on train movement	1	10-03-2026		TLM1	
No. of classes required to complete UNIT-IV: 09					No. of classes taken:	

UNIT-V: TARIFF AND POWER FACTOR IMPROVEMENT

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
38.	Desirable characteristics	1	13-03-2026		TLM2	
39.	Types of Tariffs, Flat rate, Block-rate	1	17-03-2026		TLM2	
40.	KVA maximum demand, Time of Day tariff	1	20-03-2026		TLM1, TLM2	
41.	Disadvantages of low power factor, Advantages of improved P.F.	1	24-03-2026		TLM1, TLM2	
42.	Improvement devices, Power factor improvement using static capacitor	1	27-03-2026		TLM1, TLM2	
43.	Most economical power factor	1	28-03-2026		TLM1, TLM2	
44.	Location of power factor improvement devices from consumer	1	31-03-2026		TLM2	
45.	Revision	1	04-04-2026		TLM1, TLM2	
No. of classes required to complete UNIT-V: 08					No. of classes taken:	

Contents beyond the Syllabus

Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
Economic aspects in utilization of electrical energy, Modern trends in electric traction	1	31-03-2026		TLM2, TLM6	

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

PART-C

EVALUATION PROCESS (R23 Regulation):

Evaluation Task	Marks
Assignment-I [Units-I, II & UNIT-III (Half of the Syllabus)]	A1=5
I-Descriptive Examination [Units-I, II & UNIT-III (Half of the Syllabus)]	D1=15
I-Short Answer Examination [Units-I, II & UNIT-III (Half of the Syllabus)]	SA1=10
Assignment-II [Unit-III (Remaining Half of the Syllabus), IV & V]	A2=5
II- Descriptive Examination [UNIT-III (Remaining Half of the Syllabus), IV & V]	D2=15
II- Short Answer Examination [UNIT-III (Remaining Half of the Syllabus), IV & V]	SA2=10
Mid Marks =80% of Max ((M1+Q1+A1), (M2+Q2+A2)) + 20% of Min ((M1+Q1+A1), (M2+Q2+A2))	M=30
Cumulative Internal Examination (CIE): D+SA+A	30
Semester End Examination (SEE)	70
Total Marks = CIE + SEE	100

ACADEMIC CALENDAR:

Description	From	To	Weeks
I Phase of Instructions	01-12-2025	24-01-2026	8 W
I Mid Examinations	26-01-2026	31-01-2026	1 W
II Phase of Instructions	02-02-2026	04-04-2026	9 W
II Mid Examinations	06-04-2026	11-04-2026	1 W
Preparation and Practicals	13-04-2026	18-04-2026	1 W
Semester End Examinations	20-04-2026	02-05-2026	2 W
Internship	04-05-2026	27-06-2026	8W

PART-D

PROGRAMME OUTCOMES (POs):

PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO 6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethic**s: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1: The ability to apply Software Engineering practices and strategies in software project development using open source programming environment for the success of organization.

PSO2: The ability to design and develop computer programs in networking, web applications and IoT as per the society needs.

PSO3: To inculcate an ability to analyze, design and implement database applications.

Mr P.Rathnkar Kumar	Dr. AV.G.A. Marthanda	Dr. M.S. Giridhar	Dr. P. Sobha Rani
Course Instructor	**Course Coordinator**	**Module Coordinator**	**HOD**

LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING

(AUTONOMOUS)
Accredited by NAAC & NBA (Under Tier - I), ISO 9001:2015 Certified Institution
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Phone: 08659-222933, Fax: 08659-222931

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE HANDOUT

PART-A

Name of Course Instructor: Dr.Seelam Pichi Reddy
Course Name & Code : **Technical Paper Writing and IPR** & 23MC04
L-T-P Structure : **2**-0-0 **Credits:** 0
Program/Sem/Sec : B.Tech, VI Sem **A.Y.:** 2025-26

PREREQUISITE:

COURSE EDUCATIONAL OBJECTIVES (CEOs):

This course is designed to help students understand the structure and key components of a technical paper, along with developing the skills necessary for literature review and writing a paper for initial submission. It also covers the process of Intellectual Property Rights (IPR) development, creates awareness about the scope and significance of patent rights, and provides insights into the latest advancements in IPR, including emerging software tools and technologies.

COURSE OUTCOMES (COs): At the end of the course, student will be able to

CO1	Understand the structure of the technical paper and its components. *(Understanding–L2)*
CO2	Review the literature and acquire the skills to write a technical paper for first submission. *(Understanding–L2)*
CO3	Understand the process and development of IPR. *(Understanding–L2)*
CO4	Create awareness about the scope of patent rights. *(Understanding–L2)*
CO5	Analyze the new developments in IPR including latest software. *(Analyzing–L4)*

TEXTBOOKS:

T1	Day R (2006) *How to Write and Publish a Scientific Paper*, Cambridge University Press.
T2	Halbert, *"Resisting Intellectual Property"*, Taylor & Francis Ltd, 2007.

REFERENCE BOOKS:

R1	Goldbort R (2006) *Writing for Science*, Yale University Press (available on Google Books)
R2	Highman N (1998), *Handbook of Writing for the Mathematical Sciences*, SIAM.

PART-B

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I: Planning and Preparation

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Course Introduction, importance of research writing	1	01-12-2025		TLM1, TLM2	
2.	Planning and Preparation of a paper	1	06-12-2025		TLM1, TLM2	
3.	Word order & breaking long sentences	1	08-12-2025		TLM1, TLM2	
4.	Structuring paragraphs, avoiding ambiguity	1	13-12-2025		TLM1, TLM2	
5.	Highlighting findings & maintaining tone	1	15-12-2025		TLM1, TLM2	
6.	Hedging, criticizing, paraphrasing, Plagiarism & avoiding redundancy	1	20-12-2025		TLM1, **TLM2**	
7.	Abstracts and Introductions writing practice	1	22-12-2025		TLM1, TLM2	
No. of classes required to complete UNIT-I: 07				**No. of classes taken:**		

UNIT-II: Literature Review

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
8.	Literature Review Purpose & Process	1	27-12-2025		TLM1, TLM2	
9.	Using online databases (IEEE, Scopus, Google Scholar)	1	29-12-2025		TLM1, TLM2	
10.	Writing Title & Abstract effectively	1	03-01-2026		TLM1, TLM2	
11.	Writing Results & Discussions	1	05-01-2026		TLM1, TLM2	
12.	Reviewing Conclusion & Final check	1	19-01-2026		TLM1, TLM2	
13.	Useful Technical Phrases	1	24-01-2026		TLM1, TLM2	
I Mid Examination -26-01-2026 TO 31-01-2026						
No. of classes required to complete UNIT-II: 06				**No. of classes taken:**		

UNIT-III: Process and Developemnt

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
14.	Introduction to IPR: Meaning and Purpose	1	02-02-2026		TLM1, TLM2	
15.	Types of IP: Patents, Designs, Trademarks	1	07-02-2026		TLM1, TLM2	
16.	Copyrights & Trade Secrets	1	09-02-2026		TLM3, TLM2	
17.	Process of patenting & research innovation	1	16-02-2026		TLM1, TLM2	
18.	International Scenario: WIPO, PCT	1	21-02-2026		TLM1, TLM2	
19.	Assignment: Identify IP example from industry	1	23-02-2026		TLM1, TLM2	
No. of classes required to complete UNIT-III: 06				**No. of classes taken:**		

UNIT-IV: Patent Rights

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
20.	Scope of Patent Rights	1	28-02-2026		TLM1, TLM2	
21.	Licensing & Transfer of Technology	1	02-03-2026		TLM1, TLM2	
22.	Patent Information Databases	1	07-03-2026		TLM1, TLM2	
23.	Geographical Indications & Case Laws	1	09-03-2026		TLM1, TLM2	
24.	Unit IV Review & Quiz	1	14-03-2026		TLM1, TLM2	
No. of classes required to complete UNIT-IV: 05				**No. of classes taken:**		

UNIT-V: New Developments in IPR

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
25.	Administration of Patent System	1	16-03-2026		TLM1,TLM2	
26.	IPR in Biological Systems	1	21-03-2026		TLM1,TLM2	
27.	IPR in Software and AI-generated content	1	23-03-2026		TLM1,TLM2	
28.	Traditional Knowledge & Global Case Studies	1	28-03-2026		TLM1,TLM2	
29.	Assignment: Prepare IPR case analysis	1	30-03-2026		TLM1,TLM2	
No. of classes required to complete UNIT-V: 05				**No. of classes taken:**		

Contents beyond the Syllabus

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
30.	Final Project Presentation (Technical Paper), Course Revision, Feedback & Exam Preparation	1	04-04-2026		TLM1,TLM2	

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

ACADEMIC CALENDER:

Commencement of Class work		15-07-2024	
I Phase of Instructions	01-12-2025	24-01-2026	8 W
I Mid Examinations	**26-01-2026**	**31-01-2026**	**1 W**
II Phase of Instructions	02-02-2026	04-04-2026	9 W
II Mid Examinations	**06-04-2026**	**11-04-2026**	**1 W**
Preparation and Practical's	13-04-2026	18-04-2026	1 W
Semester End Examinations	**20-04-2026**	**02-05-2026**	**2 W**

PART-C

EVALUATION PROCESS (R 23 Regulation):

Evaluation Task	Marks
Assignment-I (Units-I & II)	A1=5
I-Descriptive Examination (Units-I & II)	M1=15
I-Quiz Examination (Units-I & II)	Q1=10
Assignment-II (Unit-III, IV & V)	A2=5
II- Descriptive Examination (UNIT-III, IV & V)	M2=15
II-Quiz Examination (UNIT-III, IV & V)	Q2=10
Mid Marks =80% of Max ((M1+Q1+A1), (M2+Q2+A2)) + 20% of Min ((M1+Q1+A1), (M2+Q2+A	M=30
Cumulative Internal Examination (CIE): M	30
Total Marks = CIE	30

PART-D

PROGRAMME OUTCOMES (POs):

PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO 1	To apply the principles of thermal sciences to design and develop various thermal systems.
PSO 2	To apply the principles of manufacturing technology, scientific management towards improvement of quality and optimization of engineering systems in the design, analysis and manufacturability of products.
PSO 3	To apply the basic principles of mechanical engineering design for evaluation of performance of various systems relating to transmission of motion and power,conservation of energy and other process equipment.

Title	Course Instructor	Course Coordinator	Module Coordinator	Head of the Department
Faculty Name	Dr.S. Pichi Reddy	Dr.S. Pichi Reddy	J.Subba Reddy	Dr.M.B.S.S. Reddy
Signature				

LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
(Autonomous & Affiliated to JNTUK, Kakinada & Approved by AICTE, New Delhi, NAAC Accredited, Accredited by NBA, Certified by ISO 9001:2015)
L B Reddy Nagar, Mylavaram-522 230, Krishna District, Andhra Pradesh.

COURSE HANDOUT

Part-A

PROGRAM : B.Tech, VI-Sem., ME,
ACADEMIC YEAR : 2025-26
COURSE NAME & CODE : Heat Transfer Lab & 23ME60
L-T-P STRUCTURE : 0-0-3
COURSE CREDITS : 2
LABORATORY INSTRUCTORS : Dr. P.Ravindra Kumar/ Mr.K.Sai Babu
LABORATORY INCHARGE : Mr.K.Lakshmi Prasad
PREREQUISITE SUBJECT: Thermodynamics, Thermal Engineering

COURSE EDUCATIONAL OBJECTIVES:

The objective of this laboratory course is to gain hands on experience on the modes of heat transfer in various heat transfer equipment's used for different applications by conducting experiments.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1: Estimate the thermal conductivity of different materials and powders. **(Applying-L3)**

CO2: Compute the value of heat transfer coefficients in free and forced convection using data handbook. **(Applying-L3)**

CO3: Determine the emissivity of grey body. **(Applying-L3)**

CO4: Compare the LMTD, NTU parameters in parallel and counter flow heat exchangers. **(Analyzing-L4).**

COURSE ARTICULATION MATRIX (Correlation between COs & POs, PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	-	-	-	2	2	1	-	1	3	-	1
CO2	3	2	2	3	-	-	-	2	2	1	-	1	3	-	1
CO3	2	1	2	3	-	-	-	2	2	1	-	1	3	-	1
CO4	1	3	2	3	-	-	-	2	2	1	-	1	3	-	1

Note: Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**
1- Slight (Low), **2 –** Moderate (Medium), **3 -** Substantial (High).

BOS APPROVED TEXTBOOKS:
Lab Manuals, Heat and Mass Transfer Data Book, 6th Edition, New Age International Publishers

COURSE: B.Tech BRANCH: MECHANICAL ENGG. (Monday) BATCH: 1 A.Y:2025-26

S. No	Batch	EXP. No	0	1	2	3	4	5			6	7	8	9	10	11	12	12
		Date	01 -12 - 25	08 -12 - 25	15 -12 - 25	22 - 12 - 25	29 - 12 - 25	05 - 01 - 26	19 - 01 - 26	02 - 02 - 26	09 - 02 - 26	16 - 02 - 26	23 - 02 - 26	02 - 03 - 26	09 - 03 –26	16 – 03 -26	23 - 03 –26	30 – 03 -26
		Regd. No	CYCLE-I								CYCLE-2							
1	BATCH-I	23761A0301	DEMO	HT-1	HT-2	HT-3	HT-4	HT-5	Experiment beyond the Syllabus	Repetition	HT-1	HT-2	HT-3	HT-4	HT-5	Experiment beyond the Syllabus	Repetition	INTERNAL LAB TEST
2		23761A0302																
3		23761A0303																
4		23761A0304																
5		23761A0305																
6		23761A0306																
7	BATCH-2	23761A0307	DEMO	HT-2	HT-3	HT-4	HT-5	HT-1			HT-2	HT-3	HT-4	HT-5	HT-1			
8		23761A0308																
9		23761A0309																
10		23761A0310																
11		23761A0311																
12		23761A0312																
13	BATCH-3	23761A0315	DEMO	HT-3	HT-4	HT-5	HT-1	HT-2			HT-3	HT-4	HT-5	HT-1	HT-2			
14		23761A0316																
15		23761A0317																
16		23761A0318																
17		23761A0319																
18		23761A0320																
19	BATCH-4	23761A0321	DEMO	HT-4	HT-5	HT-1	HT-2	HT-3			HT-4	HT-5	HT-1	HT-2	HT-3			
20		23761A0323																
22		23761A0324																
22		23761A0325																
23		23761A0326																
24		23761A0329																
25		23761A0330																
26	BATCH-5	23761A0331	DEMO	HT-5	HT-1	HT-2	HT-3	HT-4			HT-5	HT-1	HT-2	HT-3	HT-4			
27		23761A0332																
28		23761A0333																
29		23761A0334																
30		23761A0335																
31		23761A0336																
32		23761A0337																

LAB INCHARGE

COURSE: B.Tech **BRANCH: MECHANICAL** **(Wednesday)** **BATCH: 2** **A.Y:2025-26**

S.No	Batch	EXP. No	0	1	2	3	4	5			6	7	8	9	10	11	12	13
		Date	03 -12 - 25	10 -12 - 25	17 -12 - 25	24 -12 - 25	31 -12 - 25	07 -01 - 26	21 -01 - 26	28 -01 - 26	04 -02 - 26	11 -02 - 26	18 -02 - 26	25 - 02 - 26	04 - 03 - 26	11 - 03 - 26	18 - 03 - 26	25 - 03 - 25
		Regd. No	CYCLE-I								CYCLE-2							
1	BATCH-I	23761A0338	DEMO	HT-1	HT-2	HT-3	HT-4	HT-5	REPETITION	Experiment beyond the syllabus	HT-1	HT-2	HT-3	HT-4	HT-5	REPETITION	Experiment beyond the syllabus	INTERNAL LAB TEST
2		23761A0340																
3		23761A0341																
4		23761A0342																
5		23761A0343																
		23761A0344																
6	BATCH-2	23761A0345	DEMO	HT-2	HT-3	HT-4	HT-5	HT-1			HT-2	HT-3	HT-4	HT-5	HT-1			
7		23761A0347																
8		23761A0348																
10		23761A0350																
11		23761A0351																
		23761A0352																
13	BATCH-3	23761A0353	DEMO	HT-3	HT-4	HT-5	HT-1	HT-2			HT-3	HT-4	HT-5	HT-1	HT-2			
14		23761A0354																
15		23761A0355																
16		23761A0356																
		23761A0357																
17		23761A0358																
19	BATCH-4	23761A0359	DEMO	HT-4	HT-5	HT-1	HT-2	HT-3			HT-4	HT-5	HT-1	HT-2	HT-3			
20		23761A0360																
22		23761A0361																
22		23761A0362																
23		23761A0363																
24		23761A0364																
		24765A0301																
25	BATCH-5	24765A0302	DEMO	HT-5	HT-1	HT-2	HT-3	HT-4			HT-5	HT-1	HT-2	HT-3	HT-4			
26		24765A0303																
27		24765A0304																
28		24765A0305																
29		24765A0306																
30		24765A0307																
		24765A0308																

LAB INCHARGE

LAKIREDDY BALIREDDY COLLEGE OF ENGINEERING (AUTONOMOUS)
MYLAVARAM
DEPARTMENT OF MECHANICAL ENGINEERING
HEAT TRANSFER LABORATORY
LIST OF EXPERIMENTS

Course: B Tech **Branch: Mech** **Sem: VI** **Batch: 2023** **A.Y: 2025-26**

S.No	Cycle	Exp Code	Name of the Experiment
1	CYCLE-I	DEMONSTRATION	DEMONSTRATION
2		HT-1	Estimate thermal conductivity of insulating powder (Asbestos).
3		HT-2	Find thermal conductivity of lagged pipe (Glass wool).
4		HT-3	Determination of thermal conductivity of metallic bar (Brass).
5		HT-4	Calculation of Transient Heat Conduction (Unsteady state Heat Conduction).
6		HT-5	Test on Pin-Fin Apparatus.
		HT-6 (Content beyond the syllabus)	**Thermal conductivity of a given liquid.**
7	CYCLE-II	HT-1	Determination of Convective Heat Transfer Co-efficient of air in Natural Convection.
8		HT-2	Estimate the convective heat Transfer coefficient of air in forced convection.
9		HT-3	Heat Pipe Demonstration
10		HT-4	Test on Tube in Tube Parallel Flow Heat Exchanger.
11		HT-5	Test on Tube in Tube Counter Flow Heat Exchanger.
12		**HT-6 (Content beyond the syllabus)**	**Test on Emissivity Measurement Apparatus.**
13		REPETITION	**REPETITION.**
14		INTERNAL	**INTERNAL LAB TEST.**

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

LAB INCHARGE

Part - C

EVALUATION PROCESS:

Evaluation Task	COs	Marks
Day to Day Evaluation	1	A=10
Record	2	B=5
Internal Examination	3	C=15
Cumulative Internal Marks : A+B+C	**1,2,3,4**	**A+B+C=30**
Semester End Examinations	**1,2,3,4**	**D=70**
Total Marks: A+B+C+D	**1,2,3,4**	**100**

PROGRAMME OUTCOMES (POs) & PROGRAM SPECIFIC OUTCOMES:

PO 1	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO 2	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO 3	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO 4	Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO 5	Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO 6	The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO 7	Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO 8	Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO 9	Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO 10	Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO 11	Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAMME SPECIFC OUTCOMES (PSOs):

PSO 1	To apply the principles of thermal sciences to design and develop various thermal systems.
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PSO 3	To apply the basic principles of mechanical engineering design for evaluation of performance of various systems relating to transmission of motion and power, conservation of energy and other process equipment.

Course Instructors	Module Coordinator	HOD
(Dr. P Ravindra Kumar) Mr.K.Sai Babu	(Dr. P.Vijay Kumar)	(Dr.M.B.S.S.Reddy)

LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING

(AUTONOMOUS)

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Approved by AICTE, New Delhi. and Affiliated to JNTUK, Kakinada

L.B. REDDY NAGAR, MYLAVARAM, KRISHNA DIST., A.P.-521 230.

Phone: 08659-222933, Fax: 08659-222931

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE HANDOUT

PART-A

Name of Course Instructor: Dr.A.Dhanunjay Kumar, Dr.B.Sudheer Kumar, Mr.K.Venkateswara Reddy

Course Name & Code : AI&ML LAB & 23ME61 **Regulation**:R23

L-T-P Structure : **0-0-3** **Credits:** 1.5

Program/Sem/Sec : B.Tech/VI **A.Y.:** 2025-26

PREREQUISITE: Python Programming

COURSE EDUCATIONAL OBJECTIVES (CEOs):

Students will acquire the knowledge of artificial intelligence and machine learning models using various software tools.

COURSE OUTCOMES (COs): At the end of the course, student will be able to

CO1	Learn various Python libraries. **(Understanding-L2)**
CO2	Do programming for regression methods. **(Applying-L3)**
CO3	Write coding for different types of neural networks. **(Applying-L3)**
CO4	Write a program for decision tree, Naïve Bayes and SVM and generate code for autoencoders. **(Applying-L3)**

COURSE ARTICULATION MATRIX (Correlation between COs, POs & PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1															
CO2															
CO3															
CO4															
1 - Low			**2 –**Medium							**3 -** High					

REFERENCES:

- Lab Manuals

PART-B

COURSE DELIVERY PLAN (LESSON PLAN):

Schedule of Experiments

S.No	Batches	Regd. Nos	Total No. of Students
1	Batch B1	23761A0301-364, 24765A0301-308	70

S. No.	Topics to be covered (Experiment Name)	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction to AI&ML Lab, Demonstration of all experiments, CEOs, and COs of the Laboratory	3	04-12-2025		TLM4	
Cycle-I						
2.	Learning of Python libraries – Numpy, Pandas, Matplotlib, Seaborn and TensorFlow	3	11-12-2025		TLM4	
3.	Numerical examples on Python libraries	3	18-12-2025		TLM4	
4.	Data Preprocessing and data cleaning using Python	3	08-01-2026		TLM4	
5.	Write a program for Linear regression	3	22-01-2026		TLM4	
6.	Write a program for Logistic regression	3	05-02-2026		TLM4	
7.	Write a program for ANN	3	12-02-2026		TLM4	
8.	Write a program for CNN	3	19-02-2026		TLM4	
Cycle-II						
9.	Write a program for RNN	3	26-02-2026		TLM4	
10.	Write a program to build a Decision tree	3	05-03-2026		TLM4	
11.	Write a program to build a Naïve Bayes classifier	3	12-03-2026		TLM4	
12.	Write a program for SVM	3	19-03-2026		TLM4	
13.	Write a program for Auto-encoder	3	26-03-2026		TLM4	
14.	Revision	3	02-04-2026		TLM4	
No. of classes required to complete:				**No. of classes taken:**		

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

PART-C

EVALUATION PROCESS (R20 Regulation):

Evaluation Task	Expt. no's	Marks
Day to Day work = **A**	1,2,3,4,5,6,7,8…	A=15
Record = **B**	1,2,3,4,5,6,7,8	B=05
Internal Test = **C**	1,2,3,4,5,6,7,8	C = 15
Cumulative Internal Examination: A + B + C = 30	1,2,3,4,5,6,7,8	**30**
Semester End Examinations = D	1,2,3,4,5,6,7,8	**D = 70**
Total Marks: A + B + C + D = 100	1,2,3,4,5,6,7,8	**100**

PART-D

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1	To build a professional career and pursue higher studies with sound knowledge in Mathematics, Science and Mechanical Engineering.
PEO 2	To inculcate strong ethical values and leadership qualities for graduates to become successful in multidisciplinary activities.
PEO 3	To develop inquisitiveness towards good communication and lifelong learning.

PROGRAMME OUTCOMES (POs):

PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding

	of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO 1	To apply the principles of thermal sciences to design and develop various thermal systems.
PSO 2	To apply the principles of manufacturing technology, scientific management towards improvement of quality and optimization of engineering systems in the design, analysis and manufacturability of products.
PSO 3	To apply the basic principles of mechanical engineering design for evaluation of performance of various systems relating to transmission of motion and power, conservation of energy and other process equipment.

Title	**Course Instructor**	**Course Coordinator**	**Module Coordinator**	**Head of the Department**
Name of the Faculty				
Signature	**Dr.A.Dhanunjay Kumar Dr.B.Sudheer Kumar Mr.K.Venkateswara Reddy**	**Dr.A.Dhanunjay Kumar**	**Mr.J.Subba Reddy**	**Dr.M.B.S.Sreekara Reddy**

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Phone: 08659-222933, Fax: 08659-222931
DEPARTMENT OF MECHANICAL ENGINEERING

COURSE HANDOUT

PART-A

Name of Course Instructor: **Mr. J. Subba Reddy, Associate Professor (T668)**
Dr. A. Nageswara Rao, Sr. Assistant Professor (T649)

Course Name & Code : Robotics and Drone Technology Lab (23MES3) **Regulations** : R23
L-T-P Structure **:** 0-0-4 **Credits** **:** 2
Program/Sem/Sec : B.Tech/VI/A Sec **A.Y.** **:** 2025-26
PREREQUISITE **:** Robotics, Mechatronics

COURSE EDUCATIONAL OBJECTIVES (CEOs):

Robotics and Drone Technologies Laboratory offers students hands-on experience in robotics and unmanned aerial systems. The course develops competency in sensor integration, actuator control, microcontroller programming, kinematic analysis, drone assembly, and navigation algorithms.

COURSE OUTCOMES (COs): At the end of the course, student will be able to

CO1	Build and program basic robotic systems using sensors, actuators, and microcontrollers to perform navigation and object manipulation tasks. **(Applying – L3)**
CO2	Simulate and analyze the kinematics and control of robotic manipulators using modelling and software tools. **(Analyzing – L4)**
CO3	Demonstrate the working principles of drone components and control mechanisms such as roll, pitch, and yaw using sensor feedback. **(Applying - L3)**
CO4	Design and assemble functional drone prototypes with capabilities such as video capture, obstacle avoidance, and payload handling. **(Applying – L3)**

COURSE ARTICULATION MATRIX (Correlation between COs, POs & PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	2	3	–	–	2	–	–	–	3	2	1	2
CO2	3	3	3	3	3	–	–	2	–	–	–	3	3	2	2
CO3	2	2	2	2	3	–	–	3	–	–	–	3	2	2	2
CO4	3	2	3	2	3	–	–	3	–	–	–	3	3	3	2

Note: 1–Slight, 2–Moderate, 3–Substantial; "–" indicates no correlation.

SOFTWARE PACKAGES: ARISTO ROBOT, C Prog, Robo Analyzer, MAT Lab, Arduino IDE, Mission Planner (ArduPilot), CATIA/Fusion 360 / SolidWorks

REFERENCE:

- Lab Manuals, Software

1. SOFTWARE USEFUL FOR ROBOTICS & DRONE TECHNOLOGIES LAB

For the experiments listed in your R&DT Lab syllabus, the following software tools are most useful and industry-relevant:

(A) Robotics Simulation & Modelling Software

1. **RoboAnalyzer**
   – For DH parameters, forward & inverse kinematics, dynamics simulation (FREE).
2. **MATLAB + Simulink Robotics Toolbox**
   – Industry standard for kinematics, dynamics, control, and PID analysis.
3. **CProg Toolbox**
   – Industry standard for kinematics, dynamics, control, and PID analysis.
4. **Gazebo / Webots**
   – Physics-based robot simulation; used with ROS for navigation tasks.

(B) Microcontroller Programming Tools

1. **Arduino IDE**
   – For programming Arduino-based mobile robots and robotic arms.
2. **Tinkercad Circuits**
   – Useful for virtual microcontroller circuit simulation.

(C) Drone Configuration & Flight Control Software

1. **Mission Planner (ArduPilot)**
   – For drone setup, tuning, sensor calibration, waypoint planning.
2. **QGroundControl (PX4)**
   – For flight modes, telemetry, camera triggering, and log analysis.
3. **Betaflight Configurator**
   – For ESC calibration, radio setup, PID tuning of quadcopters.

(D) CAD Modelling Tools

1. **CATIA/Fusion 360 / SolidWorks**
   – For 3D modelling of robotic arms, grippers, and drone frames.

2. TEXTBOOKS & REFERENCE BOOKS

TEXTBOOKS

[T1] M. P. Groover, *Industrial Robotics: Technology, Programming, and Applications*, McGraw–Hill, 1986.
[T2] K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, *Robotics: Control, Sensing, Vision, and Intelligence*, McGraw–Hill, 1987.
[T3] S. B. Niku, *Introduction to Robotics: Analysis, Systems, Applications*, 2nd ed., Wiley, 2010.
[T4] J. J. Craig, *Introduction to Robotics: Mechanics and Control*, 4th ed., Pearson, 2018.

REFERENCE BOOKS

[R1] B. Siciliano and O. Khatib (Eds.), *Springer Handbook of Robotics*, 2nd ed., Springer, 2016.
[R2] R. Siegwart, I. Nourbakhsh, and D. Scaramuzza, *Introduction to Autonomous Mobile Robots*, 2nd ed., MIT Press, 2011.
[R3] L. Meier and A. Tridgell, *PX4/ArduPilot Drone Autopilot Documentation*, Open Source UAV Project, 2020.

PART-B

COURSE DELIVERY PLAN (LESSON PLAN):

Schedule of Experiments (Section – B: B1 Batch): Wednesday (01.00 PM to 04.00 PM)

S.No	Batch	Regd. Nos	Total No. of Students
1	**Batch B1**	**23761A0301 – 312, 315 – 321, 323 -327, 330 – 337**	**32**

S. No.	Topics to be covered (Experiment Name)	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction, Lab Safety, Hardware Familiarization	3	03-12-2025		TLM4	
Cycle-I						
2.	Simulation of Mathematical Model of a Robot	3	10-12-2025		TLM4	
3.	Forward & Inverse Dynamics of a 2-DOF Manipulator	3	17-12-2025		TLM4	
4.	Arduino-Based Mobile Robot Programming	3	24-12-2025		TLM4	
5.	Obstacle Avoidance Robot Using Sensors	3	31-12-2025		TLM4	
6.	Robotic Arm Construction (Servo/Stepper)	3	07-01-2026		TLM4	
7.	Robotic Arm Programming (Pick & Place / Sorting)	3	14-01-2026		TLM4	
8.	Line Following Robot – Sensing & Control	3	21-01-2026		TLM4	
I Mid Exams: 26-01-2026 to 31-01-2026						
Cycle-II						
9.	3D CAD Modelling of Robot Arm & Gripper	3	04-02-2026		TLM4	
10.	PID Control – Theory & Simulation	3	11-02-2026		TLM4	
11.	Drone Parts, Components, ESCs, IMU Demo	3	18-02-2026		TLM4	
12.	Drone Manoeuvres: Roll, Pitch & Yaw	3	25-02-2026		TLM4	
13.	Drone Sensors & Battery Management System	3	04-03-2026		TLM4	
14.	Drone Assembly – Frame, Motors, ESCs, FC	3	11-03-2026		TLM4	
15.	Drone Camera Integration – Video/Photo Capture	3	18-03-2026		TLM4	
16.	Payload Drone – Design & Testing	3	25-03-2026		TLM4	
17.	Mid Exam based on Mini-Project Demonstration + Record Check + Viva-Voce	3	02-04-2026		TLM4	
II Mid Exams:06-04-2026 to 11-04-2026						
No. of classes required to complete 17				**No. of classes taken:**		

Schedule of Experiments (Section – B: B2 Batch): Monday (01.00 PM to 04.00 PM)

S.No	Batch	Regd. Nos	Total No. of Students
1	**Batch B2**	**23761A0338, 340 – 345, 347 – 348, 350 – 364, 24765A0301 – 308**	**32**

S. No.	Topics to be covered (Experiment Name)	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
1.	Introduction, Lab Safety, Hardware Familiarization	3	01-12-2025		TLM4	
Cycle-I						
2.	Simulation of the Mathematical Model of a Robot	3	08-12-2025		TLM4	
3.	Forward & Inverse Dynamics of a 2-DOF Manipulator	3	15-12-2025		TLM4	
4.	Arduino-Based Mobile Robot Programming	3	22-12-2025		TLM4	
5.	Obstacle Avoidance Robot Using Sensors	3	29-12-2025		TLM4	
6.	Robotic Arm Construction (Servo/Stepper)	3	05-01-2026		TLM4	
7.	Robotic Arm Programming (Pick & Place / Sorting)	3	12-01-2026		TLM4	
8.	Line Following Robot – Sensing & Control	3	19-01-2026		TLM4	
I Mid Exams: 26-01-2026 to 31-01-2026						
Cycle-II						
9.	3D CAD Modelling of Robot Arm & Gripper	3	02-02-2026		TLM4	
10.	PID Control – Theory & Simulation	3	09-02-2026		TLM4	
11.	Drone Parts, Components, ESCs, IMU Demo	3	16-02-2026		TLM4	
12.	Drone Manoeuvres: Roll, Pitch & Yaw	3	23-02-2026		TLM4	
13.	Drone Sensors & Battery Management System	3	02-03-2026		TLM4	
14.	Drone Assembly – Frame, Motors, ESCs, FC	3	09-03-2026		TLM4	
15.	Drone Camera Integration – Video/Photo Capture	3	16-03-2026		TLM4	
16.	Payload Drone – Design & Testing	3	23-03-2026		TLM4	
17.	Mid Exam based on Mini-Project Demonstration + Record Check + Viva-Voce	3	30-03-2026		TLM4	
II Mid Exams:06-04-2026 to 11-04-2026						
No. of classes required to complete 17				**No. of classes taken:**		

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

PART-C

Evaluation Process (R23 Regulation):

Evaluation Task	Expt. no's	Marks
Day to Day work = **A**	1,2,3,4,5,6,7,8…	**A = 15 M**
Record = **B**	1,2,3,4,5,6,7,8	**B = 05 M**
Internal Test = **C**	1,2,3,4,5,6,7,8	**C = 15 M**
Cumulative Internal Examination: A + B + C = 30 M	1,2,3,4,5,6,7,8	**30 M**
Semester End Examinations = D	1,2,3,4,5,6,7,8	**D = 70 M**
Total Marks: A + B + C + D = 100 M	1,2,3,4,5,6,7,8	**100 M**

ACADEMIC CALENDAR - B.Tech - VI Semester (R23):

Commencement of Class work		**01-12-2025**	
Description	**From**	**To**	**Weeks**
I Phase of Instructions	01-12-2025	24-01-2026	8 Weeks
I Mid Examinations	26-01-1026	31-01-2026	**1 Week**
II Phase of Instructions	02-02-2026	04-04-2026	9 Weeks
II Mid Examinations	06-04-2026	11-04-2026	**1 Week**
Preparation and Practicals	13-04-2026	18-04-2026	1 Week
Semester End Examinations	20-04-2025	02-05-2026	**2 Weeks**
Internship	04-05-2026	27-06-2026	**8 Weeks**
Commencement of Next (VII) Semester Class Work		**29-06-2026**	

Class Time Table - B.Tech – VI Sem: MECH (R23)

↓Day / Date→	***09.00 – 10.00***	***10.00 – 11.00***	***11.00 – 12.00***	***12.00 – 13.00***	***13.00 – 14.00***	***14.00 – 15.00***	***15.00 – 16.00***
Monday				**LUNCH BREAK**	**Batch B2**		
Tuesday							
Wednesday					**Batch B1**		
Thursday							
Friday							
Saturday							

Mini Project Tentative Titles:

S.No	Mini Project Title	Course Outcome	Description
1	Autonomous Maze-Solving Mobile Robot Using Sensor Fusion	CO 1, CO2	A robot that uses ultrasonic + IR sensors with an optimized navigation algorithm to solve a maze without human intervention.
2	Robotic Arm for Automated Object Sorting Based on Colour/Size	CO 1, CO2	A servo-based robotic manipulator designed to identify objects using sensors and sort them into categories.
3	PID-Controlled Line-Follower Robot for Precision Industrial Tracking	CO1, CO2	An advanced line follower robot with PID tuning to improve speed, stability, and tracking accuracy.
4	Quadcopter Prototype with Stabilized Aerial Photography Module	CO3, CO 4	A drone built with a camera mount and basic electronic stabilization for capturing images/videos.
5	Obstacle Avoidance Drone for Indoor Navigation Using Ultrasonic/IR Sensors	CO3, CO 4	A compact drone programmed to detect and avoid obstacles using onboard sensors.
6	Payload Delivery Drone with Load Assessment and Safety Cutoff Mechanism	CO3, CO4	A prototype quadcopter designed to carry small payloads safely with automatic overload protection.

PART-D

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1	To build a professional career and pursue higher studies with sound knowledge in Mathematics, Science and Mechanical Engineering.
PEO 2	To inculcate strong ethical values and leadership qualities for graduates to become successful in multidisciplinary activities.
PEO 3	To develop inquisitiveness towards good communication and lifelong learning.

PROGRAMME OUTCOMES (POs):

PO 1	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO 2	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO 3	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO 4	Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO 5	Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO 6	The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO 7	Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO 8	Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO 9	Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO 10	Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO 11	Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO 1	To apply the principles of thermal sciences to design and develop various thermal systems.
PSO 2	To apply the principles of manufacturing technology and scientific management towards the improvement of quality and optimisation of engineering systems in the design, analysis, and manufacturability of products.
PSO 3	To apply the basic principles of mechanical engineering design for the evaluation of the performance of various systems relating to the transmission of motion and power, conservation of energy and other process equipment.

Signature				
Name of the Faculty	Mr. J. Subba Reddy / Dr. A. Nageswara Rao	Mr. J. Subba Reddy	Mr. J. Subba Reddy	Dr.M.B.S.Sreekara Reddy
Designate	**Course Instructor**	**Course Coordinator**	**Module Coordinator**	**HOD**