LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
(Autonomous & Affiliated to JNTUK, Kakinada & Approved by AICTE, New Delhi, NAAC Accredited with 'A' grade, Accredited by NBA, Certified by ISO 9001:2015)
L B Reddy Nagar, Mylavaram-521230, Krishna District, Andhra Pradesh

COURSE HANDOUT

Part-A

PROGRAM : M.Tech. II-Semester
ACADEMIC YEAR : 2021-22
COURSE NAME & CODE : Computational Fluid Dynamics**,** 20TE07
L-T-P STRUCTURE : 3-0-0
COURSE CREDITS : 3
COURSE INSTRUCTOR : Dr. P. Ravindra Kumar
PRE-REQUISITES : Advanced Fluid Mechanics

COURSE EDUCATIONAL OBJECTIVES (CEOs):

To describe the governing equations, approaches, methodologies and applications used in CFD, distinguishes the importance of parabolic, elliptic and hyperbolic equations used in CFD and grid formations, consistency of CFD problems and numerical algorithms.

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

CO1: Classify the mathematical models for FEM, FDM, FVM techniques.
CO2: Apply the mathematical and computational methods for fluid flow simulations.
CO3: Analyze the computational problems related to fluid flows and heat transfer.
CO4: Distinguishes the grid sensitivity methods and analyze the accuracy of a numerical solution.
CO5: Identify the correct numerical algorithm to solve 1D and 2DProblems in steady and transient heat transfer conditions.

COURSE ARTICULATION MATRIX

	Computational Fluid Dynamics, 20TE07				
COs	PO1	PO2	PO3	PO4	PO5
CO1	3	-	1	3	1
CO2	2	1	2	2	1
CO3	3	3	-	1	2
CO4	2	2	-	-	-
CO5	3	3	3	3	-
Average	2.60	1.80	1.80	2.20	1.75

PG - (M.Tech-Thermal Engineering)
PROGRAM OUTCOMES (POs)

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.

PO4: Model and design thermal systems using computational and optimization techniques.

PO5: Adopt methods of energy conservation for sustainable development.

References:

1. Anderson, J.D.(Jr), *Computational Fluid Dynamics*, McGraw-Hill Book Company, 1995.

2. Hoffman, K.A., and Chiang, S.T., *Computational Fluid Dynamics*, Vol. I, II and III, Engineering Education System, Kansas, USA, 2000.

3. Chung, T.J., *Computational Fluid Dynamics*, Cambridge University Press, 2003.

4. Anderson, D.A., Tannehill, J.C., and Pletcher, R.H., *Computational Fluid Mechanics and Heat Transfer*, McGraw Hill Book Company, 2002.

Part-B

Course Delivery Plan (Lesson Plan): Section-A

S.NO	TOPIC TO BE COVERED	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods TLM	HOD Signature
Unit-1 Introduction and Governing equations of CFD						
1	Introduction about CFD	1	01-06-21		2	
2	Governing equations of CFD	1	02-06-21		2	
3	Physical Boundary Conditions – Methods of solutions of Physical Problems	1	03-06-21		2	
4	Need for Computational Fluid Dynamics	1	08-06-21		2,5	
5	Different numerical/CFD techniques – FDM, FEM, FVM	1	09-06-21		2	
6	CFD as a research and design tool – Applications in various branches of Engineering	1	10-06-21		2,5	
7	Mathematical behavior of Partial Differential Equations (Governing Equations):	1	15-06-21		2	
8	Classification of linear/ quasi linear PDE – Examples	1	16-06-21		2,5	
9	Physical Processes: Wave Equations and Equations of Heat Transfer and Fluid Flow	1	17-06-21		2	
10	Mathematical Behavior – General characteristics	1	22-06-21		2	
	Number of classes required	**10**	**Number of classes taken: 10**			
Unit-II Fluid Flow Equations and Mathematical Behavior of Partial Differential Equations						
11	**Fluid Flow Equations**: – Finite Difference Solutions of 2D Viscous Incompressible	1	23-06-21		2	
12	Problems – Vorticity and Stream Function Formulation	1	24-06-21		2	
13	**Mathematical Behavior of Partial Differential**	1	29-06-21		2	
14	Classification of quasi-linear partial differential equations,	1	30-06-21		2	
15	Methods of determining the classification	1	01-07-21		2	
16	General aspects of Discretization using Taylor	1	06-07-21		2,5	
17	Uniform and unequally spaced grid points.	1	07-07-21		2	
18	Numerical Problems	1	08-07-21		2,5	
	Number of classes required	**8**	**Number of classes taken: 09**			
Unit-III Parabolic Equations and Elliptic Equations						
19	**Parabolic equations** Finite difference formulations, Explicit methods – FTCS	1	08-07-21		2	
20	Richardson and DuFort-Frankel methods	1	13-07-21		2	
21	Crank-Nicolson and Beta formulation methods,	1	14-07-21		1,2,5	
22	Fractional step methods,	1			1,2	

23	**Elliptic Equations:** Finite difference formulation	1	20-07-21		1,2,5	
24	Solution algorithms: Jacobi-iteration method,	1	22-07-21		1, 2, 3	
25	Gauss-Siedel iteration method, point- and line-	1	27-07-21		1,2,5	
26	Successive over-relaxation methods	1	28-07-21		1,2	
27	Alternative direction implicit methods.	1	29-07-21		1,2,5	
28	Numerical Problems	1	03-08-21		1,2	
Number of classes required		**10**	**Number of classes taken: 10**			
Unit-IV **Grids with Appropriate Transformation and Grid Generation**						
29	General transformation of the equations	1	04-08-21		1	
30	Metrics and Jacobians,	1	05-08-21		1,2	
31	The transformed governing equations of the CFD,	1	10-08-21		1	
32	Boundary fitted coordinate systems	1	11-08-21		1,2,5	
33	Algebraic and elliptic grid generation techniques	1	12-08-21		1,5	
34	Adaptive grids	1	17-08-21		1,2,5	
35	**Grid Generation:** Algebraic Grid Generation	1	18-08-21		1,2,5	
36	Elliptic Grid Generation	1	24-08-21		1,2,5	
37	Hyperbolic Grid Generation, Parabolic Grid Generation	1	25-08-21		1,2,5	
38	Finite Volume Method For Unstructured Grids:	1	26-08-21		1,2,5	
39	Advantages, Cell Centered and Nodal point Approaches.	1	31-08-21		1,2,5	
Number of classes required		**11**	**Number of classes taken: 10**			
Unit-V **Numerical algorithms and Heat Transfer**						
40	FTCS explicit, FTBCS explicit methods	1	01-09-21		1,2,5	
41	Maccormack explicit and implicit	1	02-09-21		1,2,5	
42	BTCS and BTBCS implicit algorithms	1	07-09-21		1,2,5	
43	Heat Transfer applications in CFD	1	08-09-21		1,5	
44	Finite Difference Applications in Heat conduction	1	09-09-21		1,2	
45	Finite difference application in convective heat transfer	1	14-09-21		1,2	
46	Numerical problems	1	15-09-21		1,2	
Number of classes required		**7**	**Number of classes taken: 6**			
Number of classes required to complete the syllabus			**46**			

Delivery Methods (DM):

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:

Evaluation Task	COs	Marks
Assignment 1	1	
Assignment 2	2	
I-Mid Examination	1,2	
Assignment 3	3	
Assignment 4	4	
Assignment 5	5	
II-Mid Examination	3,4,5	
Evaluation of Mid Marks: B=75% of Max(B1,B2)+25% of Min(B1,B2)	1,2,3,4,5	
Cumulative Internal Examination : A+B	**1,2,3,4,5**	**A+B=40**
Semester End Examinations	**1,2,3,4,5**	**C=60**
Total Marks: A+B+C	**1,2,3,4,5**	**100**

	Course Instructor	PG Coordinator	HOD
Signature			
Name of the Faculty	Dr.P.Ravindra Kumar	Dr.P.Vijay Kumar	Dr.S.Pichi Reddy

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Phone: 08659-222933, Fax: 08659-222931

DEPARTMENT OF MECHANICAL ENGINEEING

COURSE HANDOUT

PART-A

Name of Course Instructor: Dr.V.Dhana Raju
Course Name & Code **:** Renewable Energy Technology, RET & 20TE08
L-T-P Structure **: 3-0-0** **Credits:** 3
Program/Sem/Sec : M.Tech-II **A.Y.:** 2020-2021
PREREQUISITE: Non conventional energy sources

COURSE EDUCATIONAL OBJECTIVES (CEOs) : To provide the potential importance of renewable sources of energy, energy scenario in and around the world and various renewable energy technological developments.

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

CO1	Classify the latest developments and methods emerging in the field of renewable energy technology.
CO2	Analyze the importance of renewable energy conversion systems.
CO3	Apply the knowledge of solar energy availability to various energy systems
CO4	Evaluate the power outputs of various renewable energy conversion systems
CO5	Identify the various applications of renewable energy systems.

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

COs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3		3
CO2	2	1	3		3
CO3	2	2	2		3
CO4	3	2	2		2
CO5	2	2	3		2

TEXTBOOKS:

T1 G.D.Rai, Non Conventional Energy Sources, 5th Edition Khanna Publishers, New Delhi, 2011.
T2 Khan, B.H., Non-Conventional Energy Resources, Tata McGraw Hill, New Delhi, 2006.

REFERENCE BOOKS:

R1 Bent Sorensen, Renewable Energy ,Physics ,Engineering ,Environmental Impact ,Economics & Planning ,4th Edition ,Elsevier 2011
R2 D.P.Kothari ,K.C.Singal ,RakeshRanjan ,Renewable Energy Sources and Emerging Technologies Eastern Economy Edition ,2nd Edition 2012

PART-B

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I: RENEWABLE ENERGY TECHNOLOGIES

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 RET	1	31/05/2021		TLM2	
2.	World energy use – Reserves of energy resources	1	1/06/2021		TLM2	
3.	Environmental aspects of energy utilization	1	4/06/2021		TLM2	
4.	Renewable energy scenario in India – Potentials – Achievements	1	7/06/2021		TLM2	
5.	Applications- General Principles – Heat Energy Conversion Processes	1	8/06/2021		TLM2	
6.	Engine Conversion of Solar Energy-Mechanical Energy Conversion Processes	1	14/06/2021		TLM2	
7.	Magneto Hydrodynamic Converters-Solar Radiation Conversion	1	15/06/2021		TLM2	
8.	Solar Thermal Conversion.	1	18/06/2021		TLM2	
No. of classes required to complete UNIT-I: 8				**No. of classes taken:**		

UNIT-II: ENERGY TRANSMISSION & STORAGE

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
9.	Introduction to Energy Transmission	1	21/06/2021		TLM2	
10.	Heat Storage –High Quality Energy Storage	1	22/06/2021		TLM2	
11.	Solar Energy	1	25/06/2021		TLM2	
12.	Solar thermal energy storage	1	28/6/2021		TLM2	
13.	Flat plate and concentrating collectors	1	29/6/2021		TLM2	
14.	Solar heating techniques	1	2/72021		TLM2	
15.	Solar cooling techniques	1	5/72021		TLM2	
16.	Solar desalination	1	6/72021		TLM2	
No. of classes required to complete UNIT-II: 8				**No. of classes taken:**		

UNIT-III: SOLAR APPLICATIONS AND WIND 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
17.	Solar Pond – Solar cooker	1	12/7/2021		TLM2	
18.	solar thermal power plant – Solar photo voltaic conversion	1	13/7/2021		TLM2	
19.	Solar cells- PV applications.	1	16/7/2021		TLM2	
20.	Introduction to Wind Energy	1	19/7/2021		TLM2	
21.	Wind data and energy estimation	1	20/7/2021		TLM2	

22.	Types of wind energy system	1	23/7/2021		TLM2	
23.	Performance – Details of wind turbine generator	1	26/7/2021		TLM2	
24.	safety and environmental aspects	1	27/7/2021		TLM2	
No. of classes required to complete UNIT-III: 8				**No. of classes taken:**		

UNIT-IV: BIOMASS 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
25.	Introduction to biomass energy	1	30/7/2021		TLM2	
26.	Biomass direct combustion	1	2/8/2021		TLM2	
27.	Biomass gassifier	1	3/8/2021		TLM2	
28.	Biogas plant	1	6/8/2021		TLM2	
29.	Ethanol production – Bio diesel	1	9/8/2021		TLM2	
30.	Cogeneration	1	10/8/2021		TLM2	
31.	Biomass applications.	1	13/8/2021		TLM2	
No. of classes required to complete UNIT-IV: 7				**No. of classes taken:**		

UNIT-V: OTHER RENEWABLE ENERGY SOURCES

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
32.	Introduction, Tidal energy	1	16/8/2021		TLM2	
33.	Wave energy	1	17/8/2021		TLM2	
34.	Open and closed OTEC Cycles	1	13/8/2021		TLM2	
35.	Small hydro	1	23/8/2021		TLM2	
36.	Geothermal energy	1	24/8/2021		TLM2	
37.	Fuel cell systems.	1	27/8/2021		TLM2	
No. of classes required to complete UNIT-V: 6				**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	COs	Marks
Assignment/Quiz – 1	1	-
Assignment/Quiz – 2	2	-
I-Mid Examination	1,2	B1=40
Assignment/Quiz – 3	3	-
Assignment/Quiz – 4	4	-
Assignment/Quiz – 5	5	-

II-Mid Examination	3,4,5	B2=40
Evaluation of Assignment/Quiz Marks: A=(A1+A2+A3+A4+A5)/5	1,2,3,4,5	-
Evaluation of Mid Marks: B=75% of Max(B1,B2)+25% of Min(B1,B2)	1,2,3,4,5	B=40
Cumulative Internal Examination : A+B	**1,2,3,4,5**	**A+B=40**
Semester End Examinations	**1,2,3,4,5**	**C=60**
Total Marks: A+B+C	**1,2,3,4,5**	**100**

PART-D

PROGRAMME OUTCOMES (POs):

PO 1	An ability to independently carry out research / investigation and development work to solve practical problems.
PO 2	An ability to write and present a substantial technical report/document.
PO 3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.
PO 4	Model and design thermal systems using computational and optimization techniques.
PO 5	Adopt methods of energy conservation for sustainable development.

Title	Course Instructor	Course Coordinator	P.G Coordinator	Head of the Department
Name of the Faculty	Dr.V.Dhana Raju	Dr.V.Dhana Raju	Dr.P.Vijay Kumar	Dr.S.Pichi Reddy
Signature				

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DEPARTMENT OF MECHANICAL ENGINEEING

COURSE HANDOUT

PART-A

Name of Course Instructor: S.RAMI REDDY
Course Name & Code **:** Thermal Measurement and Process Control &20TE09
L-T-P Structure **:3-0-0** **Credits:** 3
Program/Sem/Sec : M.Tech-II **A.Y.:** 2020-2021
PREREQUISITE: Instrumentation and control systems

COURSE EDUCATIONAL OBJECTIVES (CEOs): To familiarize the various methods of measuring temperature, pressure and velocity using advanced techniques

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

CO1	Apply the principles of temperature measurements with different methods
CO2	Comprehend the various techniques of pressure measurement.
CO3	Distinguish various principles for velocity measurement.
CO4	Identify the significance of analog methods used in Electro-Mechanical Systems
CO5	Describe the digital techniques in Mechanical Measurements.

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

COs	PO1	PO2	PO3	PO4	PO5
CO1	**3**		**3**		**1**
CO2	**2**		**2**		**1**
CO3	**2**		**2**		**1**
CO4	**2**		**2**		**1**
CO5	**2**		**2**		**1**

TEXTBOOKS:

T1 Bechwith-Marangoni-Lienhard –Mechanical Measurements –5th Edition

T2 E. Rathakrishnan, Instrumentation, Measurements and Experiments in Fluids, CRC press, 2007

REFERENCE BOOKS:

R1 Jack Philip Holman, Walter J. Gajda, Experimental methods for Engineers, 4thEdition: McGraw- Hill, 1984.

R2 Ernest, O. D., Measurement Systems - Applications and Design, Tata McGraw Hill Book Company, New Delhi, 2011

R3 Beckwith, Nelson Lewis Buck, Mechanical Measurements, Thomas GE 5th Edition:

Wesley Pub. Co., 1961.

R4 Holman, J. P., Experimental Methods for Engineers, Tata McGraw Hill Book Company, New Delhi, 2010.

PART-B

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I: THERMOMETRY AND HEAT FLUX MEASUREMENT

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.	Overview of thermometry	1	02/6/2021		TLM2	
2.	Thermoelectric temperature measurement	1	3/6/2021		TLM2	
3.	measurement of thermal EMF	1	4/6/2021		TLM2	
4.	Resistance thermometry	1	9/6/2021		TLM2	
5.	Pyrometer, Other methods	1	10/6/2021		TLM2	
6.	issues in measurements Heat flux measurement.	1	11/6/2021		TLM2	
7.	issues in measurements Heat flux measurement.	1	16/6/2021		TLM2	
No. of classes required to complete UNIT-I: 7				**No. of classes taken:**		

UNIT-II: PRESSURE AND FLOW MEASUREMENT

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.	Introduction, Barometers, Manometers	1	17/6/2021		TLM2	
9.	Dial type pressure gauge, Pressure Transducers	1	18/6/2021		TLM2	
10.	Pitot, Static, and Pitot-Static Tube and Its characteristics	1	23/6/2021		TLM2	
11.	Flow measurement	1	24/6/2021		TLM2	
12.	flow obstruction methods	1	25/6/2021		TLM2	
13.	magnetic flow meters	1	30/6/2021		TLM2	
14.	Low-Pressure Measurement Gauges	1	1/7/2021		TLM2	
No. of classes required to complete UNIT-II: 7				**No. of classes taken:**		

UNIT-III: VELOCITY MEASUREMENT

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
15.	Introduction, Velocity & Mach number from pressure measurements	1	2/7/2021		TLM2	
16.	Laser droplet anemometer- LDA Principle	1	7/7/2021		TLM2	
17.	Doppler shift equation, Reference beam system	1	8/7/2021		TLM2	
18.	Fringe system	1	9/7/2021		TLM2	
19.	Measurement of velocity by Hot-Wire Anemometer	1	22/7/2021		TLM2	
20.	Measurement of velocity using vortex shedding Technique	1	23/7/2021		TLM2	

21.	Fluid Jet Anemometer	1	28/7/2021		TLM2	
22.	mass flow measurement	1	29/7/2021		TLM2	
23.	volume flow measurement	1	30/7/2021		TLM2	
No. of classes required to complete UNIT-III: 9				**No. of classes taken:**		

UNIT-IV: ANALOG METHODS

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
24.	Introduction, Hale-Shaw Apparatus	1	4/8/2021		TLM2	
25.	Electrolytic Tank	1	5/8/2021		TLM2	
26.	Hydraulic Analogy	1	6/8/2021		TLM2	
27.	Hydraulic Jumps	1	11/8/2021		TLM2	
28.	Simple Harmonic Relations	1	12/8/2021		TLM2	
29.	circular and cyclic Frequency	1	13/8/2021		TLM2	
No. of classes required to complete UNIT-IV: 6				**No. of classes taken:**		

UNIT-V: DIGITAL TECHNIQUES IN MECHANICAL MEASUREMENTS

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.	Fundamental Digital Circuit Elements	1	18/8/2021		TLM2	
31.	Binary Codes	1	20/8/2021		TLM2	
32.	Simple Digital Circuitry	1	25/8/2021		TLM2	
33.	Digital computer as a measurements system tool	1	26/8/2021		TLM2	
34.	Data Processors	1	27/8/2021		TLM2	
35.	Microcomputers	1	1/9/2021		TLM2	
36.	Analog to digital Conversion	1	2/9/2021		TLM2	
37.	Digital to Analog Conversion	1	3/9/2021		TLM2	
No. of classes required to complete UNIT-V: 8				**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	COs	Marks
Assignment/Quiz – 1	1	-
Assignment/Quiz – 2	2	-
I-Mid Examination	1,2	B1=40

Assignment/Quiz – 3	3	-
Assignment/Quiz – 4	4	-
Assignment/Quiz – 5	5	-
II-Mid Examination	3,4,5	B2=40
Evaluation of Assignment/Quiz Marks: A=(A1+A2+A3+A4+A5)/5	1,2,3,4,5	-
Evaluation of Mid Marks: B=75% of Max(B1,B2)+25% of Min(B1,B2)	1,2,3,4,5	B=40
Cumulative Internal Examination : A+B	**1,2,3,4,5**	**A+B=40**
Semester End Examinations	**1,2,3,4,5**	**C=60**
Total Marks: A+B+C	**1,2,3,4,5**	**100**

PART-D

PROGRAMME OUTCOMES (POs):

PO 1	An ability to independently carry out research / investigation and development work to solve practical problems.
PO 2	An ability to write and present a substantial technical report/document.
PO 3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.
PO 4	Model and design thermal systems using computational and optimization techniques.
PO 5	Adopt methods of energy conservation for sustainable development.

Title	**Course Instructor**	**Course Coordinator**	**Module Coordinator**	**Head of the Department**
Name of the Faculty	**S.RAMI REDDY**	**K.LAKSHMI PRASAD**	**Dr.P.Vijay Kumar**	**Dr.S.Pichi Reddy**
Signature				

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COURSE HANDOUT

PROGRAM : M.Tech, II-Sem, Thermal Engineering

ACADEMIC YEAR : 2020-21

COURSE NAME & CODE : Hybrid Electric vehicles

L-T-P STRUCTURE : 3-0-0

COURSE CREDITS : 3

COURSE INSTRUCTOR : **A.Naresh Kumar**

COURSE COORDINATOR : **A.Naresh Kumar**

PRE-REQUISITE: Automobile Engineering, Basic Electrical Engineering

COURSE OBJECTIVE:

The main objective of this course is to provide the knowledge on architecture of Hybrid Electric Vehicles, Fuel cells and their sub-systems. The focus is as well on explaining the requirements of hybrid electric vehicles and Fuel-cells for automobile applications. At the same time, various design considerations in fuel cell vehicles and electric vehicles will be explained.

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

CO1 Illustrate the working of Hybrid Electric Vehicles and its systems.

CO2 Analyze the use of propulsion systems and storage systems in Hybrid Electric Vehicles.

CO3 Design and develop the propulsion and storage systems for Hybrid Electric Vehicles.

CO4 Describe the working principle of fuel cell and various types of fuel-cells.

CO5 Perform a case study on Hybrid electric vehicles and Fuel-cells.

COURSE ARTICULATION MATRIX (Correlation between CO's&PO's, PSO's):

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	3	1	2	2	2			1				1	3		1
CO2	1	3	2	3	2							1	3		1
CO3	1	2	3	3	2	1	2	1				1	3		1
CO4	3	1	2	2	2			1				1	3		1
CO5	1	2	2	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).

REFERENCES

1) Mehrdad Ehsani, Yimin Gao,Ali Emadi, 2nd edition, Modern Electric, Hybrid Electric and Fuel cell vehicles, CRC Press, Taylor and Francis Group, 2010.
2) Chris Mi, M.Abul Masrur and David Wenzhong Gao, 1st Edition, Hybrid Electric Vehicles, John Wiley & Sons, Ltd, 2011.

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I: INTRODUCTION TO HYBRID ELECTRIC VEHICLES

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.	Vehicle basics- Constituents of a conventional vehicle-Drive cycles and Drive Terrain	1	31-05-2021		TLM2	1	R1&R2	
2.	A Brief history of Hybrid Electric vehicles (HEVs), Basics of Electric Vehicles (EV), Basics of Hybrid Electric Vehicles (HEVs)	1	01-06-2021		TLM2	1	R1&R2	
3.	Architecture of HEVs- Series HEVs	1	04-06-2021		TLM2	1	R1&R2	
4.	Parallel HEVs, Series-Parallel HEVs	1	07-06-2021		TLM2	1	R1&R2	
5.	Parallel Hybrid Drive trains with Torque coupling	1	08-06-2021		TLM2	1	R1&R2	
6.	Parallel Hybrid Drive trains with both Speed coupling	1	11-06-2021		TLM2	1	R1&R2	
7.	Parallel Hybrid Drive trains with both speed Torque coupling	1	14-06-2021		TLM2	1	R1&R2	
8.	Objective Assignment	1	15-06-2021		TLM6	1	R1&R2	
No. of classes required to complete UNIT-I		08			No. of classes taken:			

UNIT-II: ELECTRIC PROPULSION SYSTEMS

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
9.	DC Motors- Operating principle and control of DC motors	1	18-06-2021		TLM2		R1&R2	
10.	Induction Motor Drives: Operating principle and Control Mechanisms	1	21-06-2021		TLM2		R1&R2	
11.	Brushless Motor Drives- Principle and Construction	1	22-06-2021		TLM2		R1&R2	
12.	Switched Reluctance Motor (SRM) Drives- Basic structure	1	25-06-2021		TLM2		R1&R2	
13.	Drive Convertor	1	28-06-2021		TLM2		R1&R2	

14.	Modes of Operation-1	1	29-06-2021		TLM2		R1&R2	
15.	Modes of Operation-2	1	02-07-2021		TLM2		R1&R2	
16.	Objective Assignment	1	05-07-2021		TLM6		R1&R2	
No. of classes required to complete UNIT-II		08			No. of classes taken:			

UNIT-III: DESIGN OF HYBRID ELECTRIC VEHICLE DRIVES

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
17.	Design of Series Hybrid Electric Vehicle Drive- Control Strategies-1	1	06-07-2021		TLM2		R1&R2	
18.	Design of Series Hybrid Electric Vehicle Drive- Control Strategies-2	1	09-07-2021		TLM2		R1&R2	
19.	Sizing of Major Components-1	1	12-07-2021		TLM2		R1&R2	
20.	Sizing of Major Components-2	1	13-07-2021		TLM2		R1&R2	
21.	Case Study for designing for various parameters	1	16-07-2021		TLM2		R1&R2	
22.	Design of Parallel Hybrid Electric Vehicle Drive	1	19-07-2021		TLM2		R1&R2	
23.	Control Strategies of Drive Train	1	20-07-2021		TLM2		R1&R2	
24.	Design of Drive Train Parameters-1	1	23-07-2021		TLM2		R1&R2	
25.	Design of Drive Train Parameters-2	1	26-07-2021		TLM2		R1&R2	
26.	Objective Assignment	1	27-07-2021		TLM6		R1&R2	
No. of classes required to complete UNIT-III		10			No. of classes taken:			

UNIT-IV: ENERGY STORAGE SYSTEMS

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
27.	Electrochemical Batteries	1	30-07-2021		TLM2		R1&R2	
28.	Lead-Acid Batteries	1	02-08-2021		TLM2		R1&R2	
29.	Nickel Based Batteries, Lithium Based Batteries	1	03-08-2021		TLM2		R1&R2	
30.	Ultra Capacitors- Basic Principles and Performance	1	06-08-2021		TLM2		R1&R2	
31.	Ultrahigh-speed flywheels and Basic Principle	1	09-08-2021		TLM2		R1&R2	
32.	Power capacity of Ultrahigh-speed flywheels	1	10-08-2021		TLM2		R1&R2	
33.	Fly Wheel technologies	1	13-08-2021		TLM2		R1&R2	
34.	Objective Assignment	1	16-08-2021		TLM6		R1&R2	
No. of classes required to complete UNIT-IV		08			No. of classes taken:			

UNIT-V: FUEL CELLS

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
35.	Operating principles of fuel cells, Fuel and oxidant consumption	1	17-08-2021		TLM2		R1&R2	
36.	Fuel cell system characteristics	1	23-08-2021		TLM2		R1&R2	
37.	Fuel cell technologies- Proton Exchange membrane fuel cells, Alkaline Fuel cells	1	24-08-2021		TLM2		R1&R2	
38.	Phosphoric acid fuel cells, Molten carbonate fuel cells	1	27-08-2021		TLM2		R1&R2	
39.	Solid oxide fuel cells	1	31-08-2021		TLM2		R1&R2	
40.	Fuel supply- Hydrogen storage- Hydrogen production	1	03-09-2021		TLM2		R1&R2	
41.	Ammonia as hydrogen carrier, Non-Hydrogen fuel cells	1	06-09-2021		TLM2		R1&R2	
42.	Fuel Cell Hybrid Vehicle Drive Train	1	07-09-2021		TLM2		R1&R2	
43.	Objective Assignment	1	13-09-2021		TLM6		R1&R2	
44.	Revision	1	14-09-2021		TLM2		R1&R2	
No. of classes required to complete UNIT-V		10			No. of classes taken:			

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

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO1: To build a professional career and pursue higher studies with sound knowledge in Mathematics, Science and Mechanical Engineering.
PEO2: To inculcate strong ethical values and leadership qualities for graduates to become successful in multidisciplinary activities.
PEO3: To develop inquisitiveness towards good communication and lifelong learning.

PROGRAMME OUTCOMES (POs):

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
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.
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.
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.
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.
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.
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.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
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.
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.
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.

PSO's:

1. To apply the principles of thermal sciences to design and develop various thermal systems.
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.
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.

A.Naresh Kumar	A.Naresh Kumar	Dr.P.Vijay Kumar	Dr.S.Pichi Reddy
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
Approved by AICTE, New Delhi. and Affiliated to JNTUK, Kakinada
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DEPARTMENT OF MECHANICAL ENGINEEING

COURSE HANDOUT

PART-A

Name of Course Instructor : K Lakshmi Prasad
Course Name & Code : English for Research Paper Writing & 20AC01
L-T-P Structure : **2-0-0** **Credits:** 0
Program/Sem/Sec : M.Tech-I **A.Y.:** 2020-21
PREREQUISITE: Nil

COURSE EDUCATIONAL OBJECTIVES (CEOs): To develop technical writing skills necessary to communicate information gained through a process of technical or experimental work.

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

CO1	Choose appropriate research topics for college classes.
CO2	Write detailed outlines for research papers and find source material for research papers.
CO3	Take and organize good notes for research.
CO4	Use appropriate academic tone and language.
CO5	Avoid plagiarizing your sources.

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

COs	PO1	PO2	PO3	PO4	PO5
CO1			**2**		
CO2		**3**	**2**		
CO3		**1**	**2**		
CO4			**2**		
CO5			**2**		

REFERENCE BOOKS:

R1 Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
R2 Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
R3 Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook
R4 Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

PART-B

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I: INTRODUCTION

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	31.05.21			
2.	Qualitative Researcher	1	01.06.21		TLM2	
3.	Quantitative vs. qualitative research	1	03.06.21		TLM2	
4.	History of qualitative research	1	07.06.21		TLM2	
5.	Major paradigms & perspectives	1	08.06.21		TLM2	
6.	Dominant paradigms of qualitative research	1	10.06.21		TLM2	
7.	Constructivism: Sub paradigms, Criticisms of interpretivism	1	14.06.21		TLM2	
No. of classes required to complete UNIT-I: 7				**No. of classes taken:**		

UNIT-II: CRITICAL THEORY

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.	Critical theory, Characteristics of critical theory	1	15.06.21		TLM2	
9.	Strategies of inquiry	1	17.06.21		TLM2	
10.	Introduction to qualitative inquiry	1	21.06.21		TLM2	
11.	Qualitative research design	1	22.06.21		TLM2	
12.	Ethnography	1	24.06.21		TLM2	
13.	Autoethnography, Case studies	1	28.06.21		TLM2	
14.	Analyzing interpretive practice, Grounded Theory	1	29.06.21		TLM2	
No. of classes required to complete UNIT-II: 7				**No. of classes taken:**		

UNIT-III: METHODS OF COLLECTING & ANALYZING EMPIRICAL MATERIALS

S. No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	HOD Sign Weekly
15.	Methods of collecting & analysing empirical materials	1	01.07.21		TLM2	
16.	interviewing, Interpretation of documents	1	05.07.21		TLM2	
17.	Images & visual methods	1	06.07.21		TLM2	
18.	Autoethnography	1	08.07.21		TLM2	
19.	personal narrative & reflexivity.	1	02.08.21		TLM2	
20.		1	03.08.21		TLM2	
No. of classes required to complete UNIT-III: 608.04.2105.08.21				**No. of classes taken:**		

UNIT-IV: ANALYZING TALK & TEXT

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.	Analyzing talk & text	1	09.08.21		TLM2	
22.	Data management & analysis methods	1	10.08.21		TLM2	
23.	Software & qualitative research	1	12.08.21		TLM2	
24.	Interpretation, evaluation & presentation	1	16.08.21		TLM2	
25.	The problem of criteria,	1	17.08.21		TLM2	

	Interpretation, Writing, Evaluation and social programs					
26.	Qualitative research and social policy	1	23.08.21		TLM2	
27.	What, why and how of technical and research writing.	1	24.08.21		TLM2	
No. of classes required to complete UNIT-IV: 7				**No. of classes taken:**		

UNIT-V: 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
28.	Literature review,	1	26.08.21		TLM2	
29.	Writing about methods	1	31.08.21		TLM2	
30.	results, and discussion of results	1	02.09.21		TLM2	
31.	Referencing,	1	06.09.21		TLM2	
32.	academic integrity, and writing for different types of readers	1	07.09.21		TLM2	
33.	academic integrity, and writing for different types of readers	1	09.09.21		TLM2	
34.	academic integrity, and writing for different types of readers	1	13.09.21		TLM2	
No. of classes required to complete UNIT-V: 7				**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	COs	Marks
Assignment/Quiz – 1	1	-

Assignment/Quiz – 2	2	-
I-Mid Examination	-	-
Assignment/Quiz – 3	3	-
Assignment/Quiz – 4	4	-
Assignment/Quiz – 5	5	-
II-Mid Examination	-	-
Evaluation of Assignment/Quiz Marks: A=(A1+A2+A3+A4+A5)/5	1,2,3,4,5	-
Evaluation of Mid Marks: B=75% of Max(B1,B2)+25% of Min(B1,B2)	1,2,3,4,5	-
Cumulative Internal Examination:	**1,2,3,4,5**	**100**
Semester End Examinations	**-**	**-**
Total Marks: A+B+C	**-**	**-**

PART-D

PROGRAMME OUTCOMES (POs):

PO 1	An ability to independently carry out research / investigation and development work to solve practical problems.
PO 2	An ability to write and present a substantial technical report/document.
PO 3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.
PO 4	Model and design thermal systems using computational and optimization techniques.
PO 5	Adopt methods of energy conservation for sustainable development.

Title	Course Instructor	Course Coordinator	Module Coordinator	Head of the Department
Name of the Faculty	**K Lakshmi Prasad**	**K Lakshmi Prasad**	**Dr.P.Vijay Kumar**	**Dr.S.Pichi Reddy**
Signature				