

# **M.E. Thermal Engineering**

## **CURRICULUM AND SYLLABI**

### **I to IV Semesters**

### **Regulation - 2020**



# **Excel**

## **ENGINEERING COLLEGE**

**(Autonomous)**

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

Accredited by NBA and NAAC with "A+" and Recognized by UGC (2f&12B)

KOMARAPALAYAM – 637303

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**DEPARTMENT OF MECHANICAL ENGINEERING  
M.E - THERMAL ENGINEERING  
REGULATION 2020  
CHOICE BASED CREDIT SYSTEM  
I TO IV SEMESTER CURRICULUM**

I SEMESTER									
Code No.	Course	Category	Periods / Week			C	Maximum Marks		
			L	T	P		CA	FE	Total
<b>Theory Course(s)</b>									
20PMA105	Advanced Numerical Methods	FC	3	2	0	4	40	60	100
20PTE101	Advanced Heat Transfer	PC	3	0	0	3	40	60	100
20PTE102	Advanced Thermodynamics	PC	3	0	0	3	40	60	100
20PTE103	Advanced Fluid Mechanics	PC	3	0	0	3	40	60	100
20PTEEXX	Professional Elective I	PE	3	0	0	3	40	60	100
20PTEEXX	Professional Elective II	PE	3	0	0	3	40	60	100
<b>Practical Course</b>									
20PTE104	Thermal Engineering Laboratory	PC	0	0	4	2	50	50	100
<b>TOTAL</b>			<b>18</b>	<b>2</b>	<b>4</b>	<b>21</b>	<b>290</b>	<b>410</b>	<b>700</b>

II SEMESTER									
Code No.	Course	Category	Periods / Week			C	Maximum Marks		
			L	T	P		CA	FE	Total
<b>Theory Course(s)</b>									
20PTE201	Instrumentation for Thermal Engineering	PC	3	0	0	3	40	60	100
20PTE202	Fuels and Combustion	PC	3	0	0	3	40	60	100
20PTE203	Environmental Engineering and Pollution Control	PC	3	0	0	3	40	60	100
20PTE204	Design and Optimization of Thermal Energy Systems	PC	3	2	0	4	40	60	100
20PTEEXX	Professional Elective III	PE	3	0	0	3	40	60	100
20PTEEXX	Professional Elective IV	PE	3	0	0	3	40	60	100
<b>Practical Course</b>									
20PTE205	Thermal Systems Simulation Laboratory	PC	0	0	4	2	50	50	100
<b>Employability Enhancement Course</b>									
20PTE206	Technical Seminar	EEC	0	0	2	1	100	0	100
<b>TOTAL</b>			<b>18</b>	<b>2</b>	<b>6</b>	<b>22</b>	<b>390</b>	<b>410</b>	<b>800</b>

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III SEMESTER									
Code No.	Course	Category	Periods / Week			C	Maximum Marks		
			L	T	P		CA	FE	Total
<b>Theory Courses</b>									
20PEE301	Research Methodology and Intellectual Property Rights	PC	3	0	0	3	40	60	100
20TEEXX	Professional Elective V	PE	3	0	0	3	40	60	100
20TEEXX	Professional Elective VI	PE	3	0	0	3	40	60	100
<b>Employability Enhancement Course</b>									
20PTE301	Project Work Phase – I	EEC	0	0	12	6	50	50	100
<b>TOTAL</b>			<b>9</b>	<b>0</b>	<b>12</b>	<b>15</b>	<b>170</b>	<b>230</b>	<b>400</b>

IV SEMESTER									
Code No.	Course	Category	Periods / Week			C	Maximum Marks		
			L	T	P		CA	FE	Total
<b>Employability Enhancement Course</b>									
20PTE401	Project Work Phase – II	EEC	0	0	24	12	50	50	100
<b>TOTAL</b>			<b>0</b>	<b>0</b>	<b>24</b>	<b>12</b>	<b>50</b>	<b>50</b>	<b>100</b>

**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 70**

**CREDITS SUMMARY**

S. No	CATEGORY	CREDITS PER SEMESTER				TOTAL CREDIT (AICTE)	CREDITS in %
		I	II	III	IV		
1	FC	4				4	5.714
2	PC	11	15	3		29	41.43
3	PE	6	6	6		18	25.71
4	EEC		1	6	12	19	27.14
<b>Total</b>		<b>21</b>	<b>22</b>	<b>15</b>	<b>12</b>	<b>70</b>	<b>100%</b>

FC - Foundation Course  
 PC - Professional Core  
 PE - Professional Electives  
 EEC - Employability Enhancement Courses

MC - Mandatory Courses (Non-Credit Courses)  
 CA - Continuous Assessment  
 FE - Final Examination

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**LIST OF ELECTIVES FOR M.E THERMAL ENGINEERING SEMESTER I**

Professional Elective I & II									
Code No.	Course	Category	Periods / Week			C	Maximum Marks		
			L	T	P		CA	FE	Total
20PTEE01	Aircraft and Jet Propulsion	PE	3	0	0	3	40	60	100
20PTEE02	Hydrogen and Fuel Cell Technologies	PE	3	0	0	3	40	60	100
20PTEE03	Energy Resources	PE	3	0	0	3	40	60	100
20PTEE04	Advanced Internal Combustion Engines	PE	3	0	0	3	40	60	100
20PTEE05	Advances in Metrology and inspection	PE	3	0	0	3	40	60	100
20PTEE06	Non Destructive testing and Failure analysis	PE	3	0	0	3	40	60	100
20PTEE07	Polymers and Composite Materials	PE	3	0	0	3	40	60	100


**LIST OF ELECTIVES FOR M.E THERMAL ENGINEERING SEMESTER II**

Professional Elective III & IV									
Code No.	Course	Category	Periods / Week			C	Maximum Marks		
			L	T	P		CA	FE	Total
20PTEE11	Computational Fluid Dynamics for Thermal Systems	PE	3	0	0	3	40	60	100
20PTEE12	Fans, Blowers and Compressors	PE	3	0	0	3	40	60	100
20PTEE13	Food Processing, Preservation and Transport	PE	3	0	0	3	40	60	100
20PTEE14	Cryogenic Engineering	PE	3	0	0	3	40	60	100
20PTEE15	Air Conditioning Systems	PE	3	0	0	3	40	60	100
20PTEE16	Materials Testing and Characterization Techniques	PE	3	0	0	3	40	60	100
20PTEE17	Alternative Fuels for IC Engines	PE	3	0	0	3	40	60	100

## LIST OF ELECTIVES FOR M.E THERMAL ENGINEERING SEMESTER III

Professional Elective V & VI									
Code No.	Course	Category	Periods/ Week			C	Maximum Marks		
			L	T	P		CA	FE	Total
20PTEE21	Advanced Power Plant Engineering	PE	3	0	0	3	40	60	100
20PTEE22	Advanced Thermal Storage Technologies	PE	3	0	0	3	40	60	100
20PTEE23	Cogeneration and Waste Heat Recovery Systems	PE	3	0	0	3	40	60	100
20PTEE24	Measurements in Thermal Engineering	PE	3	0	0	3	40	60	100
20PTEE25	Design of Heat Transfer Equipment	PE	3	0	0	3	40	60	100
20PTEE26	New & Renewable Sources of Energy	PE	3	0	0	3	40	60	100

  
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**SEMESTER- I**

<b>20PMA105</b>	<b>ADVANCED NUMERICAL METHODS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>2</b>	<b>0</b>	<b>4</b>
<b>Nature of Course</b>	Foundation Course				
<b>Pre requisites</b>	Numerical Analysis in Thermal Science				

**Course Objectives**

The course is intended to

1. Numerical methods aided by technology to solve algebraic, transcendental and differential equations
2. Apply finite element methods for solving the boundary value problems in differential equations.
3. Develop problem solving skills in numerical integration and differential equations.
4. Understanding of the application of various methods in solving engineering problems.
5. Serve as a precursor for future research.

**Course Outcomes**

On successful completion of the course, students will be able to

<b>CO. No.</b>	<b>Course Outcome</b>	<b>Bloom's Level</b>
CO1.	List the common numerical methods and how they are used to obtain approximate solutions	Remember
CO2.	Demonstrate the Eigen Value Problems And Curve Fitting	Understand
CO3.	Analyze and evaluate the accuracy of common numerical methods	Analyze
CO4.	Solve the numerical methods to obtain approximate solutions to Mathematical problems.	Apply
CO5.	Evaluate the numerical methods for various mathematical operations and tasks	Evaluate

**Course Contents:****UNIT I      NUMERICAL SOLUTIONS FOR LINEAR AND NON-LINEAR EQUATIONS      12**

System of linear equation: Gauss Elimination Method, Gauss Jordan Method, Choleski Method, Gauss-Seidel Method – System of Non-Linear equations : Method of Iteration, Newton-Raphson Method.

**UNIT II      EIGEN VALUE PROBLEMS AND CURVE FITTING      12**

Eigen value problem: Power Method – Curve fitting: Least Square approximations – Fitting a straight line – Regression Lines – Non-Linear curve fitting – Method of least square for continuous functions.

**UNIT III      NUMERICAL INTEGRATION      12**

Trapezoidal Rule - Simpson's Rules-Adaptive Quadrature Method – Gaussian Quadrature-Double integrals using Trapezoidal and Simpson's rule, Electrical Installations Devices

**UNIT IV      NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS      12**

Single step methods: Euler's Methods – Modified Euler's Method - Runge-Kutta Method of fourth order – Multi Step methods: Milne's and Adam's Predictor and Corrector Methods. Numerical solution of Ordinary Differential Equation by Finite Difference Method

**UNIT V NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS****12**

Laplace Equation: Gauss Jacobi Method, Gauss Seidel Method – Poisson Equation: Finite difference method. Parabolic Equation: Crank Nicholson Method – Hyperbolic Equation: Explicit method

**TOTAL: 60 PERIODS****TEXT BOOKS:**

1. P.Kandasamy, K.Thilagavathy, K.Gunavathy, "Numerical Methods", S.Chand and Company Ltd., Ramnagar, New Delhi, 2010.
2. Veerarajan.T and Ramachandran.T., "Numerical Methods with Programming C", Tata McGraw Hill Publishers, New Delhi, 2007.

**REFERENCE BOOKS:**

1. Grewal. B. S., and Grewal. J.S., "Numerical Methods in Engineering and Science", Seventh Edition, Khanna Publishers, New Delhi, 2007.
2. C.F. Gerald and Wheatley. P.O., "Applied Numerical Analysis", (Sixth Edition), Pearson Education, Asia, New Delhi, 2006.
3. M.K.Jain, S.R.K. Iyengar and R.K.Jain, "Numerical Methods for Scientific and Engineering Computation", Wiley Eastern Limited, New Delhi, 2004.
4. S.S.Sastry, "Introductory Methods of Numerical Analysis", Prentice Hall of India, New Delhi, 2005.
5. Balagurusamy .E., "Numerical Methods", Tata McGraw Hill Publishers, New Delhi, 1999, reprint 2007.
6. S.R.K.Iyengar, R.K.Jain, "Numerical Methods", New Age International Publishers, New Delhi, 2009.

<b>Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)</b>															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3						2	2	2			3	1	
CO2	3	3						2	2	2			3	1	
CO3	3	3						2	2	2			3	1	
CO4	3	3						2	2	2			3	1	
CO5	3	3						2	2	2			3	1	
3	High					2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				



20PTE101	ADVANCED HEAT TRANSFER	L	T	P	C
		3	0	0	3
Nature of Course	Professional core				
Pre requisites	Heat and mass transfer				

### Course Objectives

The course is intended to

1. Develop the ability to use the heat transfer concepts for various applications like finned systems, turbulence flows, high speed flows
2. Learn numerical formulation of heat equations and to analyze various heat transfer correlations
3. Understanding of the basic concepts of phase change processes and heat transfer coefficient for compact heat exchangers
4. Identify the application of numerical methods in heat transfer problems.
5. Understand the basic concepts of mass transfer.

### Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Explain the fundamental concept of heat transfer mechanisms.	Understand
CO2	Solve the free and forced convection problems for different geometries with boundary conditions	Apply
CO3	Analyze the thermal analysis and sizing of heat exchangers and to learn the heat transfer coefficient for compact heat exchanges.	Analyze
CO4	Identify numerical methods for solving the heat transfer problems	Apply
CO5	Evaluate the concepts of phase change in heat and mass transfer processes for various application	Evaluate

### Course Contents:

#### UNIT I CONDUCTION AND RADIATION HEAT TRANSFER 9

One dimensional energy equations and boundary condition - three-dimensional heat conduction equations - extended surface heat transfer - conduction with moving boundaries - radiation in gases and vapour Gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media – interaction of radiation with conduction and convection.

#### UNIT II TURBULENT FORCED CONVECTIVE HEAT TRANSFER 9

Momentum and energy equations - turbulent boundary layer heat transfer - mixing length concept - turbulence model –  $k-\epsilon$  model - analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube - high speed flows.

#### UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER 9

Condensation with shears edge on bank of tubes - boiling – pool and flow boiling - heat exchanger -  $\epsilon-NTU$  approach and design procedure - compact heat exchangers.



**UNIT IV NUMERICAL METHODS IN HEAT TRANSFER****9**

Finite difference formulation of steady and transient heat conduction problems – discretization schemes – explicit - Crank Nicolson and fully implicit schemes - control volume formulation - steady one-dimensional convection and diffusion problems - calculation of the flow field – SIMPLER algorithm.

**UNIT V MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION****9**

Mass transfer - vaporization of droplets - combined heat and mass transfers - heat transfer correlations in various applications like I.C. engines, compressors and turbines.

**TOTAL: 45 PERIODS****TEXT BOOKS:**

1. Yunus A.Cengal., Heat and Mass Transfer – A practical Approach, 3<sup>rd</sup> edition, TataMcGraw Hill 2007
2. Holman.J.P., Heat Transfer, Tata Mc Graw Hill,2002

**REFERENCES BOOKS**

1. Ghoshdastidar. P.S., Heat Transfer, Oxford University Press,2004.
2. Nag.P.K., Heat Transfer, Tata McGraw-Hill,2002.
3. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co.,1985.
4. Yadav, R., Heat and Mass Transfer, Central Publishing House,1995.

<b>Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)</b>															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			3	3		2	2		2				3	3	
CO2			3	3		2	2		2				3	3	
CO3			3	3		2	2		2				3	3	
CO4			3	3		2	2		2				3	3	
CO5			3	3		2	2		2				3	3	
3	High					2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

<b>20PTE102</b>	<b>ADVANCED THERMODYNAMICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Nature of Course</b>	Professional Core				
<b>Pre requisites</b>	Engineering Thermodynamics				

### Course Objectives

The course is intended

1. To impart knowledge of mechanical engineering fundamentals of application.
2. To gain knowledge of thermodynamics process and their applications.
3. To learn the laws thermodynamics of with suitable properties.
4. To develop a clear understanding about thermo chemistry.
5. To explore the knowledge on thermodynamics for refrigeration cycles

### Course Outcomes

On successful completion of the course, students will be able to

<b>CO. No.</b>	<b>Course Outcome</b>	<b>Bloom's Level</b>
CO1.	Classify the basic laws of Thermodynamics and study the thermodynamic relations.	Understand
CO2.	Calculate the thermodynamics properties for ideal and real gases	Evaluate
CO3.	Assess the combustion phenomenon using thermo chemistry principles	Evaluate
CO4.	Analysis the thermodynamic system by applying fundamentals of statistical thermodynamics	Apply
CO5.	Choose the power plants and study the thermodynamic phenomenological laws	Analysis

### Course contents:

#### UNIT - I: REVIEW OF THERMODYNAMIC LAWS AND COROLLARIES

9

First and second law thermodynamics, Entropy - Entropy generation. Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation.

#### UNIT-II: IDEAL AND REAL GASES AND PSYCHOMETRIC

9

Equation of state, Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Energy properties of real gases. Vapour pressure, Clausius, Clapeyron equation. Throttling, Joule-Thompson coefficient. Non reactive mixtures of perfect gases. Governing laws, Evaluation of properties, Psychrometric mixture properties and psychrometric chart, Air conditioning processes, cooling towers.

#### UNIT- III: COMBUSTION

9

Combustion Reactions, Enthalpy of formation. Entropy of formation, Reference levels of tables. Energy of formation, Heat of reaction, adiabatic flame temperature, Enthalpies, Equilibrium. Chemical equilibrium of ideal gas, The Van Hoff's equation. The chemical potential and phase equilibrium. The Gibbs phase rule.

**UNIT- IV KINETIC THEORY OF GASES AND STATISTICAL THERMODYNAMICS****9**

Basic assumption, molecular flux, collisions with a moving wall, principle of equipartition of energy, classical theory of specific heat capacity, intermolecular forces, collision cross section, mean free path, energy states and energy levels, macro and micro-scales, thermodynamic probability, thermo statistics, statistical interpretation of entropy, distribution function, application of statistics to gases-mono-atomic ideal gas, distribution of molecular velocities.

**UNIT- V: POWER CYCLES AND PHENOMENOLOGICAL LAWS****9**

Review binary vapour cycle, co-generation and combined cycles, Second law analysts of cycles. Refrigeration cycles. Thermodynamics of irreversible processes. Introduction Phenomenological laws, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermo electric circuits.

**TOTAL: 45 PERIODS****TEXT BOOKS:**

1. Holman J.P., Thermodynamics, Fourth Edition, McGraw – Hill Inc.,1988.
2. Kenneth WarkJt.m., Advanced Thermodynamics for Engineers, McGrew – Hill Inc.,1995.

**REFERENCE BOOKS:**

1. Wark, Advanced Thermodynamics, McGraw Hill 2000
2. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Cons,1988.
3. Rao Y.V.C., Postulational and Statistical Thermodynamics, Allied Publisher Limited, New Delhi,1999.
4. Sears F.W. and Salinger G.I., Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Third Edition, Narosa Publishing House, New Delhi,1993.

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COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2					3		2				3	3	
CO2	3	2					3		2				3	3	
CO3	3	2					3		3				3	3	
CO4	3	2					3		3				3	3	
CO5	3	2					3		3				3	3	
	3	High				2	Medium				1	Low			

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

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20PTE103	ADVANCED FLUID MECHANICS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fluid mechanics				

### Course Objectives

The course is intended

1. To understand the laws of fluid flow for ideal and viscous fluids
2. To apply the potential functions for standard flows and combined flows
3. To know and examine the viscous flow theory of flow through pipes
4. To recognize the boundary layer concepts with respect to fluid flow
5. To estimate the one dimensional compressible fluid flow

### Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Recollect the basic equation of fluid flow	Remember
CO2.	Demonstrate the potential functions for standard flows and combined flows	Understanding
CO3.	Examine the Viscous flow theory for various flow fields	Analyze
CO4.	Determine the Boundary Layer - displacement and momentum thickness	Evaluate
CO5.	Estimate the one dimensional compressible fluid flow	Evaluate

### Course contents

#### UNIT I BASIC EQUATIONS OF FLOW 9

Three dimensional continuity equation - differential and integral forms – equations of motion momentum and energy and their engineering applications

#### UNIT II POTENTIAL FLOW THEORY 9

Rotational and Irrotational flows - Circulation – Vorticity - stream and potential functions for standard flows and combined flows – representation of solid bodies by flow patterns. Pressure distribution over stationery and rotating cylinders in a uniform flow - Magnus effect - Kutta – Zhukovsky theorem. Complex potential functions

#### UNIT III VISCOUS FLOW THEORY 9

Laminar and turbulent flow - laminar flow between parallel plates - Poiseuille's equation for flow through circular pipes. Turbulent flow - Darcy Weisbach equation for flow through circular pipe - friction factor - smooth and rough pipes - Moody diagram losses during flow through pipes. Pipes in series and parallel – transmission of power through pipes

**UNIT IV BOUNDARY LAYER CONCEPT****9**

Boundary Layer - displacement and momentum thickness - laminar and turbulent boundary layers in flat plates - velocity distribution in turbulent flows in smooth and rough boundaries - laminar sub layer.

**UNIT V COMPRESSIBLE FLUID FLOW****9**

One dimensional compressible fluid flow – flow through variable area passage – nozzles and diffusers – fundamentals of supersonics – normal and oblique shock waves and calculation of flow and fluid properties over solid bodies (like flat plate, wedge, diamond) using gas tables

**TOTAL: 45 PERIODS****TEXT BOOKS:**

1. Streeter V.L., Wylie E.B. and Bedford K.W., Fluid Mechanics, WCB McGraw Hill, Boston, 1998.
2. Munson B.R., Young D.F. and Okiisi, T.H., Fundamentals of Fluid Mechanics, John Wiley and Sons Inc., New York, 1990.


**REFERENCE BOOKS:**

1. Bansal R.K., Fluid Mechanics, Saurabh and Co., New Delhi, 1985.
2. Kumar K.L., Engineering Fluid Mechanics, Eurasia Publishing House, New Delhi, 2002.
3. Schlichting H., Boundary layer theory, Mc Graw Hill Book Company, 1979
4. Shames, Mechanics of Fluids, Mc Graw Hill Book Company, 1962.8.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		3				2		3				3	3	
CO2	3		3				2		3				3	3	
CO3	3		3				2		3				3	3	
CO4	3		3				2		3				3	3	
CO5	3		3				2		3				3	3	
	3	High				2	Medium				1	Low			

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video presentation/Assignment	10	5				
Attendance	10	5				

  
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<b>20PTE104</b>	<b>THERMAL ENGINEERING LABORATORY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>
<b>Nature of Course</b>	Professional Core				
<b>Pre requisites</b>	Thermal Engineering and Heat transfer				

### Course Objectives

The course is intended

1. To make the students to learn the importance of various types of I.C engines and analyze them using commercial and open source software.
2. To study the characteristics of fuels/Lubricates used in IC Engines
3. To study the Performance of Air Compressor
4. To study the heat transfer phenomena predict the relevant coefficient using implementation
5. To find out the performance of cooling tower

### Course Outcomes

On successful completion of the course, students will be able to

<b>CO. No.</b>	<b>Course Outcome</b>	<b>Bloom's Level</b>
CO1.	Perform experiments on engines and draw characteristics.	Understanding
CO2.	Determine the volumetric efficiency of a two-stage reciprocating air compressor as a function of receiver pressure and air blower.	Analyze
CO3.	Determine the coefficient of performance using parallel and counter flow Heat Exchangers.	Evaluate
CO4.	Interpret and evaluate the heat transfer coefficient using forced convection and free convection experimental set-up.	Understanding
CO5.	Contrast Fourier law of conduction for composite slab and Newton's law of cooling for pin-fin apparatus.	Apply

### Course contents

<b>S.No</b>	<b>Exercises</b>	<b>CO Mapping</b>	<b>Blooms Level</b>
<b>IC engines lab</b>			
1	Constant Speed Performance Test on Single Cylinder CI Diesel Engine.	1	Apply
2	Performance Test on Single-Cylinder CI Diesel Engine.	1	Apply
3	Retardation Test on Single-Cylinder CI Diesel Engine.	1	Apply
4	Determination of volumetric efficiency of the air compressor as a function of receiver pressure	2	Apply
5	Performance and characteristics studies on air Blower.	2	Apply
6	Determination of calorific value of solid and liquid fuels-calorimeter	2	Apply

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7	Determination of cloud and pure points of oil products - cloud and pour point apparatus	2	Apply
8	Performance study in a cooling tower.	2	Apply
<b>Heat transfer lab</b>			
9	Performance study on parallel and counter flow Heat Exchangers.	3	Apply
10	Determination of cloud and pure points of oil products - cloud and pour point apparatus	3	Apply
11	Performance study in a refrigeration systems	3	Apply
12	Natural Convection Apparatus: Determination of experimental and empirical values of convection heat transfer coefficient from a Vertical Heated Cylinder losing heat to quiescent air	4	Apply
13	Forced Convection Apparatus: Determination of theoretical, experimental and empirical values of convection heat transfer coefficient for internal forced convection through a circular GI pipe	4	Apply
14	Pin-Fin Apparatus: Determination of temperature distribution, efficiency and effectiveness of the fin working in forced	5	Apply

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		3		3	3		3	3	3	2		3	3	
CO2	3		3		3	3		3	3	3	2		3	3	
CO3	3		3		3	3		3	3	3	2		3	3	
CO4	3		3		3	3		3	3	3	2		3	3	
CO5	3		3		3	3		3	3	3	2		3	3	
3		High				2		Medium				1	Low		

**TOTAL: 60 PERIODS**



**SEMESTER-II**

20PTE201	INSTRUMENTATION FOR THERMAL ENGINEERING	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Thermal Engineering				

**Course Objectives**

The course is intended to

1. Provide knowledge on various measuring instruments for thermal engineering.
2. Understand the various steps involved in error analysis and uncertainty analysis.
3. Provide knowledge on advance measurement techniques.
4. Gain knowledge of measurement process and their applications.
5. Explore the knowledge on analysis of measurement

**Course Outcomes**

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Understand the suitability, accuracy and uncertainty associated with the instrument used for measuring thermal system parameters.	Understand
CO2.	Identify The microprocessors and computers in measurement.	Apply
CO3	Select measuring instruments for advanced applications like process industry.	Apply
CO4	Compare and analysis the performance of advance measurement techniques	Analyze
CO5	Calculate heat release from an IC engine, understand use of flow visualization techniques	Evaluate

**Course Contents:****UNIT I MEASUREMENT CHARACTERISTICS 10**

Instrument Classification, Characteristics of Instruments – Static and dynamic, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments

**UNIT II MICROPROCESSORS AND COMPUTERS IN MEASUREMENT 8**

Data logging and acquisition – use of sensors for error reduction, elements of microcomputer interfacing, intelligent instruments in use.

**UNIT III MEASUREMENT OF PHYSICAL QUANTITIES 9**

Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables.

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**UNIT IV ADVANCE MEASUREMENT TECHNIQUES****8**

Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, heat flux sensors, Telemetry in measurement.

**UNIT V MEASUREMENT ANALYSIS****10**

Chemical thermal, magnetic and optical gas analyzers, measurement of smoke, Dust and moisture, gas chromatography, spectrometry, measurement of pH, Review of basic measurement techniques.

**TOTAL: 45 PERIODS****TEXT BOOKS:**

- 1 Barnery, Intelligent Instrumentation, Prentice Hall of India, 1988
2. Bolton.W, Industrial Control & Instrumentation, Universities Press, Second Edition, 2001.

**REFERENCE BOOKS:**

1. Holman J.P., Experimental methods for engineers, McGraw-Hill, 2012.
2. John G Webster, The measurement, Instrumentation and sensors Handbook, CRC and IEE Press, 1999.
4. Morris A.S, Principles of Measurements and Instrumentation Prentice Hall of India, 1998.
5. Nakra, B.C., Choudhry K.K., Instrumentation, Measurements and Analysis Tata McGraw Hill, New Delhi, 2nd Edition 2003.
7. T.G.Beekwith R.D., Marangoni and J.H. Lienhard, Mechanical Measurements, Pearson Education, 2001.

<b>Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)</b>																
COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO1	2	2	3		2								3	3		
CO2	2	2	3		2								3	3		
CO3	2	2	3		2								3	3		
CO4	2	2	3		2								3	3		
CO5	2	2	3		2								3	3		
	3	High				2	Medium					1	Low			

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

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<b>20PTE202</b>	<b>FUELS AND COMBUSTION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Nature of Course</b>	Professional Core				
<b>Pre requisites</b>	Fundamental Concepts of Combustion Science and Engineering				

### Course Objectives

The course is intended to

1. Describes the environmental problems arising due to the advanced technology.
2. Explains and provides knowledge on the energy resources and their management without wastage and prevention of over-exploitation.
3. Analysis of various types of pollution and its control methods for solving the problems arising due to them.
4. Learn combustion mechanisms of gaseous, liquid and solid fuels.
5. Explain the equipment's involved in combustion

### Course Outcomes

On successful completion of the course, students will be able to

<b>CO. No.</b>	<b>Course Outcome</b>	<b>Bloom's Level</b>
CO1.	Summarize the characterization of fuels.	Understand
CO2.	Select the various solid and liquid fuels	Apply
CO3.	Discuss about the various gaseous fuels	Understand
CO4.	Analyze the process of combustion processes	Analyze
CO5.	clarify the equipment's involved in combustion	Analyze

### Course Contents:

#### **UNIT I FUEL CHARACTERIZATION 8**

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels - Fuels Analysis - Proximate and Ultimate Analysis - Moisture Determination - Calorific Value - Gross & Net Calorific Values - Calorimetry - DuLong's Formula for CV Estimation - Flue gas Analysis - Orsat Apparatus - Fuel & Ash Storage & Handling - Spontaneous Ignition Temperatures.

#### **UNIT II SOLID OF LIQUID FUELS 9**

Solid Fuels Types - Coal Family - Properties - Calorific Value - ROM, DMMF, DAF and Bone Dry Basis - Ranking - Bulk & Apparent Density - Storage - Washability - Coking & Caking Coals - Renewable Solid Fuels - Biomass - Wood Waste - Agro Fuels - Manufactured Solid Fuels. Liquid Fuels Types - Sources - Petroleum Fractions - Classification - Refining - Properties of Liquid Fuels - Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number.

#### **UNIT III GASEOUS FUELS 8**

Gaseous Fuel Classification - Composition & Properties - Estimation of Calorific Value - Gas Calorimeter. Rich & Lean Gas - Wobbe Index - Natural Gas - Dry & Wet Natural Gas - Stripped NG - Foul & Sweet NG - LPG - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas - Town Gas - Coal Gasification - Gasification Efficiency - Non - Thermal Route - Biogas - Digesters - Reactions - Viability - Economics.

**UNIT IV COMBUSTION: STOICHIOMETRY & KINETICS****12**

Stoichiometry – Mass Basis & Volume Basis – Excess Air Calculation – Fuel & Flue Gas Compositions - Calculations – Rapid Methods – Combustion Processes – Stationary Flame – Surface or Flameless Combustion – Submerged Combustion – Pulsating & Slow Combustion Explosive Combustion. Mechanism of Combustion – Ignition & Ignition Energy – Spontaneous Combustion – Flame Propagation – Solid, Liquid & Gaseous Fuels Combustion – Flame Temperature – Theoretical, Adiabatic & Actual – Ignition Limits – Limits of In-flammability.

**UNIT V COMBUSTION EQUIPMENTS****8**

Coal Burning Equipment's – Types – Pulverized Coal Firing – Fluidized Bed Firing – Fixed Bed & Recycled Bed – Cyclone Firing – Spreader Stokers – Vibrating Grate Stokers – Sprinkler Stokers, Traveling Grate Stokers. Oil Burners – Vaporizing Burners, Atomizing Burners – Design of Burners. Gas Burners – Atmospheric Gas Burners – Air Aspiration Gas Burners – Burners Classification according to Flame Structures – Factors Affecting Burners & Combustion.

**TOTAL: 45 PERIODS****Text Books:**

1. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990.
2. B.I. Bhatt and S.M. Vora, Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 1984.
3. Blokh A.G., Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corp, 1988.

**Reference Books:**

1. Sharma SP., Mohan Chander, Fuels & Combustion, Tata McGraw Hill, 1984.
2. Holman J.P., Thermodynamics, Fourth Edition, McGraw-Hill Inc., 1988.
3. Yunus A. Cengel and Michael A. Boles, Thermodynamics, McGraw-Hill Inc., 2006.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3					2	2							1	2
CO2	3					2	2							1	2
CO3	3					2	2							1	2
CO4	3					2	2							1	2
CO5	3					2	2							1	2
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
Video presentation	10	5				
Attendance	10	5				

Passed in Board of studies Meeting on 21.10.2020 Approved in Academic Council Meeting on 06.11.2020

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20PTE203	ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Fundamentals of Chemistry				

### Course Objectives

The course is intended to

1. Impart knowledge on the atmosphere and its present condition, global warming and eco-legislations.
2. Detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation.
3. Elaborate on the technologies available for generating energy from waste.

### Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Explain emission standards	Understand
CO2.	Identify the pollution with suitable waste management system	Analysis
CO3.	Classify the types of power generation	Understand
CO4.	State the pollution from various industries.	Remember
CO5.	Select different types of waste water treatment	Apply

### Course Contents:

#### UNIT – I INTRODUCTION 9

Global atmospheric change – greenhouse effect – Ozone depletion - natural cycles - mass and energy transfer – material balance – environmental chemistry and biology – impacts – environmental. Legislations

#### UNIT – II AIR POLLUTION 9

Pollutants - sources and effect – air pollution meteorology – atmospheric dispersion – indoor air quality - control methods and equipments - issues in air pollution control – air sampling and measurement.

#### UNIT – III WATER POLLUTION 9

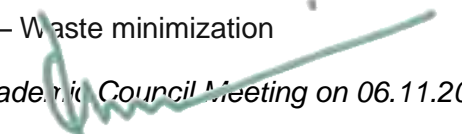
Water resources - water pollutants - characteristics – quality - water treatment systems – waste water treatment - treatment, utilization and disposal of sludge - monitoring compliance with standards.

#### Unit - IV WASTE MANAGEMENT 9

Sources and Classification – Solid waste – Hazardous waste - Characteristics – Collection and Transportation - Disposal – Processing and Energy Recovery – Waste minimization

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**Unit – V OTHER TYPES OF POLLUTION FROM INDUSTRIES****9**

Noise pollution and its impact - oil pollution - pesticides - instrumentation for pollution control - water pollution from tanneries and other industries and their control – environment impact assessment for various projects – case studies. Radiation pollution: types, sources, effects, control of radiation pollution.

**TOTAL: 45 PERIODS****Text Books:**

1. Bishop P., Pollution Prevention: Fundamentals and Practice, McGraw-Hill International Edition, McGraw-Hill book Co, Singapore, 2000.
2. G.Masters, Introduction to Environmental Engineering and Science Prentice Hall of India Pvt Ltd, New Delhi, 2003

**Reference Books:**

1. Arcadio P Sincero and G.A.Sincero, Environmental Engineering–A Design Approach, Prentice Hall of India Pvt Ltd, New Delhi, 2002.
2. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2<sup>nd</sup> Edition, Prentice Hall, 1998.
3. H.Ludwig, W.Evans, Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands N.J.(1991).
4. Rao C.S., Environmental Pollution Control Engineering, 2<sup>nd</sup> Edition, New Age International Publishers, 2006.

<b>Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)</b>															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		3					3	3			2			3	
CO2		3					3	3			2			3	
CO3		3					3	3			2			3	
CO4		3					3	3			2			3	
CO5		3					3	3			2			3	
	3		High			2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

Passed in Board of Studies Meeting on 21.10.2020 Approved in Academic Council Meeting on 06.11.2020

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**UNIT IV DYNAMIC BEHAVIOUR 12**

Steady state Simulation, Laplace Transformation, Feedback Control Loops, Stability Analysis, Non-Linearities

**UNIT V APPLICATIONS AND CASE STUDIES 12**

Case studies of optimization in thermal systems problems- Dealing with uncertainty- probabilistic techniques – Trade-offs between capital and energy using Pinch analysis

**TOTAL: 60 PERIODS****TEXT BOOKS:**

1. B.K.Hodge, Analysis and Design of Thermal Systems, Prentice Hall Inc.,1990.
2. Rao S. S., Engineering Optimization Theory and Practice, New Age Publishers,2000.

**REFERENCES BOOKS:**

1. D.J. Wide, Globally Optimal Design, Wiley- Interscience,1978.
2. Kapur J. N., Mathematical Modelling, Wiley Eastern Ltd, New York,1989.
3. Stoecker W. F., Design of Thermal Systems, McGraw Hill Edition,1989.
4. YogeshJaluria , Design and Optimization of Thermal Systems , CRC Press ,2007.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2		2								3	3	
CO2	3	3	2		2								3	3	
CO3	3	3	2		2								3	3	
CO4	3	3	2		2								3	3	
CO5	3	3	2		2								3	3	
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTE205	<b>THERMAL SYSTEMS SIMULATION LABORATORY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>
<b>Nature of Course</b>	Professional Core				
<b>Pre requisites</b>	Thermodynamics, Thermal Engineering I & II				

**Course Objectives**

The course is intended

1. To learn the modeling and simulation analysis of various thermal engineering application using analysis software's
2. To perform a thermal system simulation and solve for a workable solution using the method of successive substitution
3. To generate an objective function and the appropriate constraints for a complete thermal system design problem

**Course Outcomes**

On successful completion of the course, students will be able to

<b>CO. No.</b>	<b>Course Outcome</b>	<b>Bloom's Level</b>
CO1.	Make use of heat exchanger analysis using NTU and LMTD method	Apply
CO2.	Experiment with convection heat transfer analysis – Velocity boundary layer and internal flow.	Apply
CO3.	Experiment with radiation heat transfer analysis – emissivity and critical radius of insulation analysis method	Apply
CO4.	Examine the lumped heat transfer analysis method	Apply
CO5.	Simply the condensation heat transfer analysis	Apply

**Course Contents:**

<b>S.No</b>	<b>Exercises</b>	<b>CO Mapping</b>	<b>Blooms Level</b>
<b>IC engines lab</b>			
1	Heat exchanger analysis – NTU method	1	Apply
2	Heat exchanger analysis – LMTD method	1	Apply
3	Convection heat transfer analysis – Velocity boundary layer.	2	Apply
4	Convection heat transfer analysis – Internal flow	2	Apply
5	Radiation heat transfer analysis – Emissivity	3	Apply
6	Critical radius of insulation	3	Apply
7	Lumped heat transfer analysis	4	Apply
8	Condensation heat transfer analysis	5	Apply

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		3		3	3		3	3	3	2		3	3	
CO2	3		3		3	3		3	3	3	2		3	3	
CO3	3		3		3	3		3	3	3	2		3	3	
CO4	3		3		3	3		3	3	3	2		3	3	
CO5	3		3		3	3		3	3	3	2		3	3	
	3	High				2	Medium					1	Low		

TOTAL: 60 PERIODS

*N. Natarajan*  
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 Approved in Academic Council Meeting on 26.11.2020  
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20PTE206	<b>TECHNICAL SEMINAR</b>			L	T	P	C
				0	0	2	1
<b>Nature of Course</b>	Employability Enhancement Course						
<b>Pre requisites</b>	Undergraduate Project Presentation						

**COURSE OBJECTIVES:**

1. To Enhance the ability of self-study
2. To encourage the students to study advanced engineering developments
3. To Improve presentation and communication skills
4. To prepare and present technical reports.
5. To encourage the students to use various teaching aids such as overhead projectors, PowerPoint presentation and demonstration models.

**COURSE OUTCOMES:**

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	To review, prepare and present technological developments	Understand
CO2	To face the placement interviews	Understand
CO3	To improve the speaking skills	Understand
CO4	To develop your confidence in handling information, making useful notes, and presenting an argument	Understand
CO5	To improve the research and development Knowledge	Understand

**GUIDELINES**

- The student is expected to present a seminar in one of the current topics in the field of Thermal Engineering related issues / technology.
- The seminar shall be of 30 minutes duration and give presentation to the Seminar Assessment Committee (SAC).
- A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
- In a session of two periods per week, 4 students are expected to present the seminar.
- Students are encouraged to use various teaching aids such as power point presentation and demonstrative models.
- Students are required to prepare a seminar report in the prescribed format given by the department.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	-	-			3	2	3	2	3	2	2	-	-	-
CO2	-	-	-	-	-	1	1	3	3	3	2	2	-	-	-
CO3	-	-	-	-	-	3	1	2	2	2	3	3	-	-	-
CO4	-	-	-	-	-	2	2	3	3	2	3	2	-	-	-
CO5	-	-	-	-	-	3	1	3	2	2	3	3	-	-	-
	3	High					2	Medium			1	Low			

TOTAL: 30 PERIODS

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 Passed in Board of studies Meeting on 21.10.2020  
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 Approved in Academic Council Meeting on 21.10.2020  
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**UNIT V ROCKET THRUST CHAMBER****10**

Combustion in solid and liquid propellant classification – rockets of propellants and Propellant Injection systems – Non-equilibrium expansion and supersonic combustion – Propellant feed systems – Reaction Control Systems - Rocket heat transfer.

**TOTAL = 45 PERIODS****Reference Books:**

1. Bonney E.A., Zucrow N.J, Principles of Guided Missile Design, Van Nostranc Co., 1956.
2. Khajuria P.R. and Dubey S.P., Gas Turbines and Propulsive Systems, Dhanpat Rai Publications, 2003.
3. Mattingly J.D., Elements of Gas turbine Propulsion, McGraw Hill, 1st Edition, 1997.
4. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition, Addition – Wesley Publishing Company, New York, 2009.
5. S.M.Yahya, Fundamentals of Compressible Flow, Third edition, New Age International Pvt Ltd, 2003.
6. Zucrow N.J., Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons, New York, 1970.
7. Zucrow N.J., Aircraft and Missile Propulsion, Vol. I and Vol. II, John Wiley and Sons Inc, New York, 1975.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2										3	1	2
CO2	3	3	2										3	1	2
CO3	3	3	2										3	1	2
CO4	3	3	2										3	1	2
CO5	3	3	2										3	1	2
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				



20PTEE02	HYDROGEN AND FUEL CELL TECHNOLOGIES	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fundamental knowledge in Hydrogen and Fuel Cell Technologies				

### Course Objectives

The course is intended to

1. To study in detail on the hydrogen production methodologies
2. To learn the possible applications and various storage options.
3. To understand the working principle of a typical fuel cell
4. To gain the knowledge of various types fuel cell and to elaborate on its thermodynamics and kinetics.
5. To study the cost effectiveness and eco-friendliness of Fuel Cells.

### Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Define the properties of hydrogen and its production methodologies	Remember
CO2.	Illustrate the hydrogen storage techniques and its applications	Understand
CO3.	Explain on working principle of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics	Understand
CO4.	Outline the concepts of different fuel cells	Understand
CO5.	Analysis the cost effectiveness and eco-friendliness of Fuel Cells	Apply

### Course Contents:

#### UNIT – I HYDROGEN – BASICS AND PRODUCTION TECHNIQUES: 9

Hydrogen – physical and chemical properties, salient characteristics. Production of hydrogen – steam reforming – water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water

#### UNIT – II HYDROGEN STORAGE AND APPLICATIONS: 9

Hypothesis: sources, types and characteristics; Sample survey: sample and census survey, probability, non- probability and mixed sampling

#### UNIT – III FUEL CELLS: 9

History – principle - working - thermodynamics and kinetics of fuel cell process – performance evaluation of fuel cell – comparison on battery vs fuel cell.

#### UNIT - IV FUEL CELL – TYPES: 9

Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits

#### UNIT – V APPLICATION OF FUEL CELL AND ECONOMICS: 9

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell, Future trends in fuel cells.

**TOTAL: 45 PERIODS**

Passed in Board of Studies Meeting on 21.10.2020

Approved in Academic Council Meeting on 06.11.2020

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**Reference Books:**

1. Viswanathan B. and Aulice Scibioh.M, Fuel Cells – Principles and Applications, Universities Press, 2006.
2. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma, 2005.
3. Bent Sorensen (Sørensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, UK2005.
4. Kordesch K. and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany1996.
5. Hart A.B. and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, New York Ltd., London 1989.
6. Jeremy Rifkin, the Hydrogen Economy, Penguin Group, USA2002. Barclay F.J., Fuel Cells, Engines and Hydrogen, Wiley, 2009.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2		2						2		3	3	
CO2	3	2	2		2						2		3	3	
CO3	3	2	2		2						2		3	3	
CO4	3	2	2		2						2		3	3	
CO5	3	2	2		2						2		3	3	
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE03	ENERGY RESOURCES	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fundamentals of Mechanical Engineering				

### Course Objectives

1. To explain concepts of various forms of Non-renewable and renewable energy.
2. To outline division aspects and utilization of renewable energy sources for both domestic and industrial applications.
3. To study the environmental and cost economics of using renewable energy sources compared to fossil fuels.
4. Learn the present energy scenario and the need for energy conservation.
5. Analyze the environmental aspects of renewable energy resources.

### Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Classify the commercial energy and renewable energy sources.	Understand
CO2.	Contrast the working principle of various energy systems.	Understand
CO3.	Identify Winds energy as alternate form of energy and to know how it can be tapped.	Apply
CO4.	Explain bio gas generation and its impact on environment.	Analyze
CO5.	Compare the Geothermal & Tidal energy, its mechanism of production and its applications.	Analyze

### Course Contents:

#### UNIT I COMMERCIAL ENERGY 9

Coal, Oil, Natural gas, Nuclear power and Hydro - their utilization pattern in the past, present and future projections of consumption pattern - Sector-wise energy consumption – environmental impact of fossil fuels – Energy scenario in India – Growth of energy sector and its planning in India.

#### UNIT II SOLAR ENERGY 9

Solar radiation at the earth's surface – solar radiation measurements – estimation of average solar radiation - solar thermal flat plate collectors - concentrating collectors – solar thermal applications - heating, cooling, desalination, drying, cooking, etc – solar thermal electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant – Net metering concept.

#### UNIT III WIND ENERGY 9

Nature of the wind – power in the wind – factors influencing wind – wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection - wind energy conversion devices - classification, characteristics, applications – offshore wind energy - Hybrid systems - safety and environmental aspects – wind energy potential and installation in India – Repowering concept.

**UNIT IV BIO-ENERGY****9**

Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - direct combustion – biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - types of biogas Plant - applications - alcohol production from biomass – bio diesel production – Urban waste to energy conversion - Biomass energy programme in India.

**UNIT V OTHER TYPES OF ENERGY****9**

Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plant - ocean wave energy conversion - tidal energy conversion – small hydro - geothermal energy-geothermal power plant–hydrogen production and storage-Fuel cell– principle of working - various types - construction and applications.

**TOTAL = 45 PERIODS****Reference Books:**

1. Sukhatme S.P., "Solar Energy", Tata McGraw Hill, 1984.
2. Twidell J.W. and Weir A., "Renewable Energy Sources", EFN Spon Ltd., 1986.
3. Kishore V.V.N., "Renewable Energy Engineering and Technology", Teri Press, New Delhi, 2012
4. Peter Gevorkian, "Sustainable Energy Systems Engineering," McGraw-Hill, 2007.
5. Kreith F. and Kreider J.F., "Principles of Solar Engineering", McGraw-Hill, 1978.
6. Godfrey Boyle, "Renewable Energy Power for a Sustainable Future", Oxford University Press, U.K, 1996.
7. Veziroglu T.N., "Alternative Energy Sources", Vol 5 and 6, McGraw-Hill, 1990.
8. Anthony San Pietro, "Biochemical and Photosynthetic aspects of Energy Production", Academic Press, 1980.
9. Bridgwater A.V., "Thermochemical processing of Biomass", Academic Press, 1981.
10. Bent Sorensen, "Renewable Energy", Elsevier, Academic Press, 2011.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			2				3			3		3	3	1
CO2	3			2				3			3		3	3	1
CO3	3			2				3			3		3	3	1
CO4	3			2				3			3		3	3	1
CO5	3			2				3			3		3	3	1
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE04	ADVANCED INTERNAL COMBUSTION ENGINES	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Thermal Engineering				

**Course Objectives**

The course is intended to

1. To update the knowledge in engine exhaust emission control.
2. To make aware of alternate fuels and its significance.
3. To enable the students to understand the recent developments in IC Engines.
4. To educate them with the technological advancements of I.C Engine.
5. To educate students with the technological advancements of S.I Engine.

**Course Outcomes**

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	List the various types of I.C. Engines and its Cycles of operation.	Remember
CO2.	Explain the performance parameters in IC Engines.	Understand
CO3.	Summarize the causes of emission.	Understand
CO4.	Estimate the engines performance with alternative fuels.	Evaluate
CO5.	Justify the environmental and social impact of IC Engines.	Evaluate

**Course Contents:****UNIT I SPARK IGNITION ENGINES 9**

Spark ignition Engine mixture requirements – Fuel – Injection systems – Monopoint, Multipoint injection, Direct injection – Stages of combustion – Normal and abnormal combustion – factors affecting knock – Combustion chambers.

**UNIT II COMPRESSION IGNITION ENGINES 9**

States of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers – Fuel spray behavior – spray structure, spray penetration and evaporation – air motion – Introduction to Turbo charging.

**UNIT III POLLUTANT FORMATION AND CONTROL 9**

Pollutant – Sources – Formation of carbon monoxide, Unburnt hydrocarbon, NO<sub>x</sub>, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters and Particulate Traps – Methods of measurements and Introduction to emission norms and Driving cycles.

**UNIT IV ALTERNATIVE FUELS 9**

Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications.

**UNIT V RECENT TRENDS 9**

Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines – Plasma Ignition – Measurement techniques – laser Doppler, Anemometry. Use of nano technology in IC Engines.

**TOTAL = 45 PERIODS**

**Text Books:**

1. Heinz Heisler, "Advanced Engine Technology," SAE International Publications, USA, 1998
2. Ganesan V., "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2007

**Reference Books:**

1. Duffy Smith, "Auto fuel Systems, The Good Heart Willox Company, Inc., 1989.
2. Heywood, J.B., "Internal Combustion Engine Fundamentals, McGraw-Hill, 1988.
3. K.K. Ramalingam, "Internal Combustion Engine fundamentals, SciTech Publications, 2002.
4. Kirpal Singh, "Automobile Engineering Vol - I, Standard Publishers, Delhi 2013.
5. R.B. Mathur and R.P.Sharma, "Internal Combustion Engines, Dhanapat Rai Publications, 1993.
6. V. Ganesan, "Internal Combustion Engines, II Edition, Tata McGraw-Hill Education, 2002.
7. Willard W. Pulkrabek, "Engineering Fundamentals of the Internal Combustion Engine, Prentice Hall, 1997.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2						2				3	3	1
CO2	3	3	2						2				3	3	1
CO3	3	3	2						2				3	3	1
CO4	3	3	2						2				3	3	1
CO5	3	3	2						2				3	3	1
	3	High				2	Medium				1	Low			

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				



20PTEE05	ADVANCES IN METROLOGY AND INSPECTION	L	T	P	C
		3	0	0	3
Nature of Course	Professional elective				
Pre requisites	Inspection, Analysis of Thermal Components				

### Course Objectives

1. To basic concepts in various methods of engineering measurement techniques and applications.
2. To understand the importance of measurement and inspection in manufacturing industries.
3. To make the students capable of learning to operate and use advanced metrological devices with ease in industrial environments.
4. To design and develop a new measuring methods.
5. Understand the advanced measurement techniques used in industries.

### Course Outcomes

On successful completion of the course, students will be able to

CO No	Course Outcomes	Blooms Level
CO 1	Understand the advanced measurement principles	Understand
CO 2	Select the sophisticated measurement and inspection facilities	Remember
CO 3	Choose the new measuring methods for Inspection	Evaluate
CO 4	List the Measuring instruments and its applications	Analyze
CO 5	Applying the Image Processing technique in Metrology	Apply

### Course Contents:

<b>UNIT I</b>	<b>CONCEPTS OF METROLOGY</b>	<b>8</b>
Terminologies – Standards of measurement – Errors in measurement – Interchangeability and Selective assembly – Accuracy and Precision – Calibration of instruments – Basics of Dimensional metrology and Form metrology		
<b>UNIT II</b>	<b>MEASUREMENT OF SURFACE ROUGHNESS</b>	<b>9</b>
Definitions – Types of Surface Texture: Surface Roughness Measurement Methods- Comparison, Contact and Non-Contact type roughness measuring devices, 3D Surface Roughness Measurement, Nano Level Surface Roughness Measurement – Instruments.		
<b>UNIT III</b>	<b>INTERFEROMETRY</b>	<b>8</b>
Introduction, Principles of light interference – Interferometers – Measurement and Calibration – Laser Interferometry.		
<b>UNIT IV</b>	<b>MEASURING MACHINES AND LASER METROLOGY</b>	<b>10</b>
Tool Makers Microscope – Microhite – Coordinate Measuring Machines – Applications – Laser Micrometer, Laser Scanning gauge, Computer Aided Inspection techniques - In-process inspection, Machine Vision system-Applications.		
<b>UNIT V</b>	<b>IMAGE PROCESSING FOR METROLOGY</b>	<b>10</b>
Overview, Computer imaging systems, Image Analysis, Preprocessing, Human vision system, Image model, Image enhancement, gray scale models, histogram models, Image Transforms - Examples.		

**TOTAL: 45 PERIODS**

Passed in Board of studies Meeting on 21.10.2020

Approved in Academic Council Meeting on 06.11.2020

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**REFERENCES**

1. "ASTE Handbook of Industries Metrology", Prentice Hall of India Ltd., 1992.
2. Bewoor, A.K. and Kulkarni, V.A., "Metrology and Measurement", Tata Mc Graw-Hill, 2009.
3. Galyer, F.W. and Shotbolt, C.R., "Metrology for engineers", ELBS, 1990.
4. Gupta, I.C., "A Text Book of engineering metrology", Dhanpat Rai and Sons, 1996.
5. Jain, R.K., "Engineering Metrology", Khqanna Publishers, 2008.
6. Rajput, R.K., "Engineering Metrology and Instrumentations", Kataria & Sons Publishers, 2001.
7. Smith, G.T., "Industrial Metrology", Springer, 2002
8. Sonka, M., Hlavac, V. and Boyle, R., "Image Processing, Analysis, and Machine Vision", Cengage- Engineering, 2007.
9. Whitehouse, D.J., "Surface and their measurement", Hermes Penton Ltd, 2004.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3						2	2	2			3	1	
CO2	3	3						2	2	2			3	1	
CO3	3	3						2	2	2			3	1	
CO4	3	3						2	2	2			3	1	
CO5	3	3						2	2	2			3	1	
	<b>3</b>	<b>High</b>				<b>2</b>	<b>Medium</b>					<b>1</b>	<b>Low</b>		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

Passed in Board of Studies Meeting on 21.10.2020

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Approved in Academic Council Meeting on 06.11.2020

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**Text Books:**

1. Baldev Raj, Jayakumar, Thavasimuthu. M., Practical Non-destructive testing, Narosa Publishing, 1997.
2. Das. A.K., Metallurgy of failure analysis, Tata McGraw Hill, 1992. Heinz Heisler, „Advanced Engine Technology,” SAE International Publications,USA,1998
3. Ganesan V.” Internal Combustion Engines” , Third Edition, Tata McGraw-Hill ,2007

**Reference Books:**

1. Hellier, Handbook of Non-Destructive Evaluation, McGraw-Hill Professional, 1<sup>st</sup>edition (2001).
2. J. Thomas Schmidt, K. Skeie and P. MacIntire, ASNT Non Destructive Testing Handbook: Magnetic Particle Testing, American Society for Nondestructive Testing, American Society for Metals, 2nd edition (1989).
3. V. S. Cecco, G. V.Drunen and F.L. Sharp, Eddy current Manual: Test method, Vol.1,Chalk River Nuclear Laboratories (1983).
4. B.P.C. Rao, Practical Eddy Current Testing, Alpha Science International Limited (2006).
5. N. A. Tracy, P. O. Moore, Non-Destructive Testing Handbook: Liquid Penetrant Testing,Vol.2, American Society for Nondestructive Testing, 3rd edition (1999).
6. Don E. Bray and Roderic K. Stanley, Nondestructive Evaluation: A Tool in Design, Manufacturing and Service, CRC Press (1996).

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)																
COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO1	3	3			2				1				3	3		
CO2	3	3			2				1				3	3		
CO3	3	3			2				1				3	3		
CO4	3	3			2				1				3	3		
CO5	3	3			2				1				3	3		
	3	High				2	Medium				1	Low				

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

<b>20PTEE07</b>	<b>POLYMERS AND COMPOSITE MATERIALS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Nature of Course</b>	Professional elective				
<b>Pre requisites</b>	Composites, polymers and its Characterization				

**Course Objectives**

1. To teach the students basic concepts in various methods of engineering Materials and applications.
2. Understand the importance of Composite Materials in manufacturing industries.
3. To impart knowledge on types, physical properties and processing of polymer matrix composites
4. To design and develop a new Processing methods involved in Ceramics composites.
5. Understand the advanced Process involved in metal matrix composites used in industries.

**Course Outcomes**

<b>CO No</b>	<b>Course Outcomes</b>	<b>Blooms Level</b>
CO 1	Define the composite material, reinforcements of polymer composites.	Remember
CO 2	Develop knowledge on processing, interfacial properties and application of composites.	Apply
CO 3	Select reinforcements of polymer matrix composites	Evaluate
CO 4	List the Process of Metal matrix Composites	Analyze
CO 5	Importance of Processing technique in Ceramic Matrix Composites and its applications.	Apply

**Course Contents:****UNIT I PROCESSING OF POLYMERS**

9

Chemistry and Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics - Extrusion – Injection Moulding – Blow Moulding – Compression and Transfer Moulding – Casting – Thermo Forming. General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Thermal bonding – Applications.

**UNIT II FIBERS AND MATRIX MATERIALS**

9

Fibers – Fabrication, Structure, properties and applications – Glass fiber, Boron fiber, carbon fiber, organic fiber, ceramic and metallic fibers - whiskers–Fabrication of Matrix materials – polymers, metals and ceramics and their properties – interfaces – Wettability – Types of bonding at the interface  
– Tests for measuring interfacial strength - Physical and chemical properties.

**UNIT III PROCESSING OF POLYMER MATRIX COMPOSITES**

9

Thermoset matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding with Bulk Moulding Compound and sheet Moulding Compound – thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection moulding – interfaces in PMCs - structure, properties and application of PMCs –recycling of PMCs.

**UNIT IV PROCESSING OF METAL MATRIX COMPOSITES**

9

Metallic matrices: aluminium, titanium, magnesium, copper alloys – processing of MMCs: liquid state, Solid state, in situ fabrication techniques – diffusion bonding – powder metallurgy techniques- interfaces in MMCs – mechanical properties – machining of MMCs – Applications.

## UNIT V PROCESSING OF CERAMIC MATRIX COMPOSITES AND CARBON-CARBON COMPOSITES

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – in situ chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, sol-gel interfaces in CMCs – mechanical properties and applications of CMCs – Carbon-carbon Composites –applications.

**TOTAL: 45 PERIODS**

### REFERENCE BOOKS:

1. ASM Handbook – Composites, Vol-21, 2001, ISBN: 978-0-87170-703-1.
2. Harold Belofsky, Plastics, Product Design and Process Engineering, Hanser Publishers,2002.
3. Jamal Y. Sheikh-Ahmad, Machining of Polymer Composites, Springer, USA, 2009. ISBN: 978-0-387-35539-9.
4. Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2012,ISBN:978-0-387-74364-6.
5. Mallick P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010, ISBN:0849342058.
6. Mallick, P.K. and Newman.S., Composite Materials Technology, Hanser Publishers,2003.
7. Said Jahanmir, Ramulu M. and Philp Koshy, Machining of Ceramics and Composites, Marcel Dekker Inc., New York, 1999, ISBN:0-8247-0178-x.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3						2	2	2			3	1	
CO2	3	3						2	2	2			3	1	
CO3	3	3						2	2	2			3	1	
CO4	3	3						2	2	2			3	1	
CO5	3	3						2	2	2			3	1	
	<b>3</b>	<b>High</b>				<b>2</b>	<b>Medium</b>					<b>1</b>	<b>Low</b>		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

## ELECTIVE III &amp; IV

20PTEE11	COMPUTATIONAL FLUID DYNAMICS FOR THERMAL SYSTEMS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Computational Fluid Dynamics for Thermal Systems				

**Course Objectives**

The course is intended to

1. This course aims to introduce numerical modeling and its role in the field of heat, fluid flow and combustion.
2. It will enable the students to understand the various discretization methods and solving methodologies
3. To create confidence to solve complex problems in the field of heat transfer and fluid dynamics.
4. To develop finite volume discretized forms of the CFD equations.
5. To formulate explicit & implicit algorithms for solving the Euler Equations & Navier Stokes Equations.

**Course Outcomes**

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Summarize the governing differential equation in heat transfer	Understand
CO2.	Solve the steady diffusion problems for different dimensions	Apply
CO3.	Examine the finite volume method	Analyze
CO4.	List the various type of flow process	Analyze
CO5.	Discuss the description of turbulent flow and its modelling	Create

**Course Contents:**

**UNIT I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETIZATION TECHNIQUES 9**

Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretization techniques using finite difference methods – Taylor's Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

**UNIT II DIFFUSION PROCESSES: FINITE VOLUME METHOD 9**

Steady one-dimensional diffusion, Two and three dimensional steady state diffusion problems, Discretization of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson's schemes, Stability of schemes

**UNIT III CONVECTION – DIFFUSION PROCESSES: FINITE VOLUME METHOD 9**

One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme

**UNIT IV FLOW PROCESSES: FINITE VOLUME METHOD 9**

Discretization of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms



**UNIT V TURBULENCE AND ITS MODELING****9**

Description of turbulent flow, free turbulent flows, flat plate boundary layer and pipe flow, Algebraic Models, One equation model,  $k - \epsilon$  &  $k - \omega$  models Standard and High and Low Reynolds number models

**TOTAL: 45 PERIODS****References**

1. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and HeatTransfer " Hemisphere Publishing Corporation, New York, USA,2012.
2. Bose, T.K., "Numerical Fluid Dynamics" Narosa Publishing House,1997.
3. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag,1991.
4. Fletcher, C.A.J. "Computational Techniques for fluid Dynamics 2" Specific Techniques for Different Flow Categories, Springer – Verlag,1988.
5. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
6. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
7. Subas and V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.

<b>Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)</b>															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			3	3		2	2		2				3		2
CO2			3	3		2	2		2				3		2
CO3			3	3		2	2		2				3		2
CO4			3	3		2	2		2				3		2
CO5			3	3		2	2		2				3		2
	3	High				2	Medium				1	Low			

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				



20PTEE12	FANS, BLOWERS AND COMPRESSORS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	Fundamental knowledge in Prime movers				

**Course Objectives**

The course is intended to

1. To develop knowledge about turbo machinery and its working principles.
2. To formulate analysis of compressors, centrifugal blowers and testing of fans.
3. To understand the design concepts of compressors
4. To analysis various testing and control techniques of fans
5. To understand the blowers control techniques in thermal applications

**Course Outcomes**

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Understand about Turbo machinery and its working principles	Remember
CO2.	Analysis function and characteristics of blowers and fans	Apply
CO3.	Understand the design concepts of compressors	Understand
CO4.	Analysis various testing and control techniques of fans	Apply
CO5.	Apply a blowers control techniques in thermal applications	Apply

**Course Contents:****UNIT – I PRINCIPLES OF TURBO MACHINERY: 9**

Introduction to turbo machines - Transfer of energy to fluids - Performance characteristics - fan laws - Dimensionless parameters - Specific speed - selection of centrifugal, axial, and mixed flow machines

**UNIT – II ANALYSIS OF CENTRIFUGAL BLOWERS AND FANS: 9**

Centrifugal Blowers: Theoretical characteristic curves, Euler's characteristics and Euler's velocity triangles, losses and hydraulic efficiency, flow through impeller inlet volute, diffusers, leakage disc friction mechanical losses multivane impellers of impulse type, cross flow fans.

**UNIT – III ANALYSIS OF COMPRESSOR: 9**

Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist stage design, surge and stall, stator and casing, mixed flow impellers.

**UNIT - IV TESTING AND CONTROL OF FANS: 9**

Fan testing, noise control, materials and components blower regulation, speed control, throttling, control at discharge and inlet

**UNIT – V APPLICATIONS OF BLOWERS: 9**

Applications of blowers, induced and forced draft fans for air conditioning plants, cooling towers, ventilation systems, booster systems.

**TOTAL: 45 PERIODS**

Passed in Board of Studies Meeting on 21.10.2020

**CHAIRMAN - BOARD OF STUDIES**

Approved in Academic Council Meeting on 06.11.2020

**CHAIRMAN - ACADEMIC COUNCIL**

### Reference

1. S.M. Yahya, Turbines, Compressors and Fans, Tata McGraw-Hill Education, 1987.
2. Stepanoff A.J., Turbo blowers, John Wiley & Sons, 1970.
3. Brunoeck, Fans, Pergamon Press, 1973.
4. Austin H. Church, Centrifugal pumps and blowers, John Wiley and Sons, 1980.
5. Dixon, Fluid Mechanics, Thermodynamics of turbomachinery, Pergamon Press, 1984.
6. Dixon, Worked examples in turbomachinery, Pergamon Press, 1984.
7. Earl Logan Jr., Ramendra Roy, Handbook of Turbomachinery, Second Edition, Marcel Dekker, Inc, New York, 2003.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	3						2				3	3	
CO2	2	2	3						2				3	3	
CO3	2	2	3						2				3	3	
CO4	2	2	3						2				3	3	
CO5	2	2	3						2				3	3	
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE13	FOOD PROCESSING, PRESERVATION AND TRANSPORT	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	None				

### Course Objectives

The course is intended to

1. To develop knowledge about food products, Mechanism of food spoilage critical microbial growth requirements and design for control of microorganisms
2. To understand methods of food processing and preservation of foods
3. To understand the various methods of food freezing and drying.
4. To understand the concepts of cold storage design & instrumentation systems
5. To understand packing and transporting food products.

### Course Outcomes

On successful completion of this course the student will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Develop knowledge about food products, Mechanism of food spoilage critical microbial growth requirements and design for control of microorganisms	Apply
CO2.	Summaries methods of food processing and preservation of foods	Understand
CO3.	Analysis the various methods of food freezing and drying techniques	Analyze
CO4.	Classify the concepts of cold storage design & instrumentation systems	Understand
CO5.	List the packing and transporting food products.	Analyze

### Course contents:

#### UNIT I INTRODUCTION 9

Microbiology of Food Products, Mechanism of food spoilage critical microbial growth requirements, Design for control of microorganisms, The role of HACCP, Sanitation, Regulation and standards.

#### UNIT II PROCESSING & PRESERVATION 12

Thermodynamic properties and Transfer properties, Water content, Initial freezing temperature, Ice fraction, Transpiration of fresh fruits & vegetables, Food processing techniques for Dairy products, Poultry, Meat, Fruits & Vegetables.

#### UNIT III FREEZING & DRYING 12

Precooling, Freeze drying principles, Cold storage & freezers, Freezing drying limitations, Irradiation techniques, Cryofreezing, Numerical and analytical methods in estimating Freezing, Thawing times, Energy conservation in food industry.

#### UNIT IV COLD STORAGE DESIGN & INSTRUMENTATION 7

Initial building consideration, Building design, Specialized storage facility, Construction methods, Refrigeration systems, Insulation techniques, Control & instrumentation, Fire protection, Inspection & maintenance

**UNIT V PACKAGING AND TRANSPORT****5**

Refrigerated transportation, Refrigerated containers & trucks, Design features, Piping & Role of cryogenics in freezing & transport. Basic packaging materials, types of packaging, Packaging design. Packaging for different types of foods.

**TOTAL : 45 PERIODS****References**

1. Alan Rodes, Principles of Industrial Microbiology, Pregmon International Pub.,1989.
2. Ibrahim Dincer, Heat Transfer in Food Cooling Applications, Taylor & Francis Pub.,1997.
3. Stanley E. Charm, Fundamentals of Food Engineering, III Edition, AVI Pub. Company Inc. 1989.
4. Clive V.I. Dellino, Cold and Chilled Storage Technology, Van Nostrand Reinhold Pub. New York,1991.
5. Arora C.P., Refrigeration and Air conditioning II Edition, McGraw-Hill, Pub.,2000.
6. ASHRAE Handbook, Refrigeration, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Atlanta,1988.
7. Fellows P.J., Food processing Technology: Principle and Practices, Wood Head Publishing, 1997.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		2					2	2				3	1	2
CO2	3		2					2	2				3	1	2
CO3	3		2					2	2				3	1	2
CO4	3		2					2	2				3	1	2
CO5	3		2					2	2				3	1	2
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE14	<b>CRYOGENIC ENGINEERING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Nature of Course</b>	Professional Elective				
<b>Pre requisites</b>	Thermodynamics, fluid mechanics and heat transfer, along with a basic understanding of engineering materials.				

### Course Objectives

The course is intended to

1. To understand the basic concepts of cryogenic systems
2. To gain the knowledge of air-liquefaction processes to practical situations.
3. To Interpret and analyze the separation of cryogenic gases techniques.
4. To understand the classification of Cryogenic refrigeration systems
5. To understand the various measuring flow techniques in cryogenic engineering

### Course Outcomes

On successful completion of this course the student will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Illustrate the concepts of cryogenic systems.	Understand
CO2.	Relate air-liquefaction processes to practical situations.	Remember
CO3.	Interpret and analyze the separation of cryogenic gases techniques.	Evaluate
CO4.	Classify Cryogenic refrigeration systems.	Remember
CO5.	Apply the various measuring flow techniques in cryogenic engineering	Apply

### Course contents:

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Definition and Engineering Applications of Cryogenics, Properties of solids for cryogenic systems		
<b>UNIT II</b>	<b>REFRIGERATION AND LIQUEFACTION</b>	<b>9</b>
Simple Linde cycle, Pre-cooled Joule-Thomson cycle, dual pressure cycle, Simon helium liquefier, classical cascade cycle, mixed-refrigerant cascade cycle		
<b>UNIT III</b>	<b>ULTRA-LOW-TEMPERATURE REFRIGERATORS</b>	<b>9</b>
Definition and Fundamentals regarding ultra-low temperature refrigerators, Equipment associated with low-temperature systems, Various Advantages and Disadvantages.		
<b>UNIT IV</b>	<b>STORAGE AND HANDLING OF CRYOGENIC REFRIGERANTS</b>	<b>9</b>
Storage and Transfer systems, Insulation, Various Types of Insulation typically employed, Poly Urethane Foams (PUFs) and Polystyrene Foams (PSFs), Vacuum Insulation, and so on		
<b>UNIT V</b>	<b>APPLICATIONS</b>	<b>9</b>
Broad Applications of Cryogenic Refrigerants in various engineering systems		

**TOTAL = 45 PERIODS**

**TEXT BOOKS**

1. Traugott H.K. Frederking and S.W.K. Yuan, Cryogenics - Low Temperature Engineering and Applied Sciences, Yutopian Enterprises, 2005.
2. Arora, C.P., Refrigeration and Air-conditioning, Tata-McGraw Hill, 2008.
3. A. R. Jha, Cryogenic Technology and Applications, Butterworth-Heinemann, 2005.

**REFERENCES**

1. Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.
2. Randall F. Barron, Cryogenic Systems, McGraw-Hill, 1985.
3. Scott R.B., Cryogenic Engineering, Van Nostrand and Co., 1962.
4. Herald Weinstock, Cryogenic Technology, Boston Technical Publishers, Inc., 1969.
5. Robert W. Vance, Cryogenic Technology, John Wiley & Sons, Inc., New York, London.
6. G.Venkatarathnam, Cryogenic Mixed Refrigerant Processes, Springer Publication, 2010.
7. J.G.Weisend, Hand Book of Cryogenic Engineering —II, Taylor and Francis, 1998.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		2			1			2					3	1
CO2	3		2			1			2					3	1
CO3	3		2			1			2					3	1
CO4	3		2			1			2					3	1
CO5	3		2			1			2					3	1
	3	High				2	Medium				1	Low			

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

Passed in Board of Studies Meeting on 21.10.2020

**CHAIRMAN - BOARD OF STUDIES**

Approved in Academic Council Meeting on 06.11.2020

**CHAIRMAN - ACADEMIC COUNCIL**



20PTEE15	AIR CONDITIONING SYSTEMS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Elective				
Pre requisites	None				

### Course Objectives

1. To learn the psychometric concepts underlying Air conditioning process.
2. To learn the design features and load estimation principles of specific Air conditioning system.
3. To learn about the critical auxiliary systems such as air distribution circuits, water distribution circuits etc.
4. To evaluate the cooling load for air conditioning systems used for various Characteristics
5. To understand the conceptually the design of a HVAC system in automobiles.

### Course Outcomes

On successful completion of this course the student will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Illustrate the cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems	Understand
CO2.	List the properties, applications and environmental issues of different refrigerants	Analyze
CO3.	Classify the fundamental principles and different methods of air conditioning	Analyze
CO4.	Evaluate the cooling load for air conditioning systems used for various Characteristics	Evaluate
CO5.	Analyze the air conditioning systems in automobiles	Analyze

### Course contents:

#### UNIT I PSYCHROMETRY AND AIR CONDITIONING PROCESSES 9

Moist Air properties, use of Psychrometric Chart, Various Psychrometric processes, Air Washer, Adiabatic Saturation. Summer and winter Air conditioning, Enthalpy potential and its insights.

#### UNIT II LOAD ESTIMATION 10

Thermal comfort – Design conditions – Solar Radiation-Heat Gain through envelopes – Infiltration and ventilation loads – Internal loads – Procedure for heating and cooling load estimation.

#### UNIT III AIR CONDITIONING SYSTEMS 8

Thermal distribution systems – Single, multi zone systems, terminal reheat systems, Dual duct systems, variable air volume systems, water systems and Unitary type systems.

#### UNIT IV AIR DISTRIBUTION AND CONTROL 10

Flow through Ducts, Static & Dynamic Losses, Diffusers, Duct Design–Equal Friction Method, System Balancing, Fans & Duct System Characteristics, Fan Arrangement Variable Air Volume systems, Air Handling Units and Fan Coil units – Control of temperature, humidity, air flow and quality.

#### UNIT V HVAC SYSTEM IN AUTOMOBILES 8

Automotive System layout and Components- Commonly used Refrigerants- Safety devices – Climate control – Fuel efficiency aspects.

**TOTAL = 45 PERIODS**



**References**

1. Ali Vedavarz, Sunil Kumar, Mohammed Iqbal, Hussain Handbook of Heating, Ventilation and Air conditioning for Design Implementation, Industrial press Inc, 2007.
2. Arora C.P., Refrigeration and Air Conditioning, Tata McGraw Hill Pub. Company, 2010.
3. Ashrae, Fundamentals and equipment, 4 volumes-ASHRAE Inc.2005.
4. Carrier Air Conditioning Co., Handbook of Air Conditioning Systems design, McGraw Hill, 1985.
5. Jones, Air Conditioning Engineering, Edward Arnold pub.2001.
6. Kuehn T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall,1998
7. Langley, Billy C., Refrigeration and Air Conditioning Ed. 3, Engie wood Cliffs (N.J) Prentice Hall1986.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		3		3			3	3		3			3	1	2
CO2		3		3			3	3		3			3	1	2
CO3		3		3			3	3		3			3	1	2
CO4		3		3			3	3		3			3	1	2
CO5		3		3			3	3		3			3	1	2
	3	High				2	Medium					1	Low		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE16	<b>MATERIALS TESTING AND CHARACTERIZATION TECHNIQUES</b>	L	T	P	C
		3	0	0	4
<b>Nature of Course</b>	Professional elective				
<b>Pre requisites</b>	Material testing				

### Course Objectives

1. This course aims to impart knowledge on various techniques of material characterization.
2. Understand the importance of microstructure evaluation, crystal structure analysis.
3. To impart knowledge on Chemical and Thermal Analysis.
4. To Design and develop a new methods involved in Mechanical testing.
5. Understand the advanced Process involved in Dynamic tests in industries.

### Course Outcomes

On successful completion of this course the student will be able to

CO No	Course Outcomes	Blooms Level
CO 1	Define the Micro and Crystal structure analysis	Understand
CO 2	Develop the knowledge on Electron Microscopy techniques.	Remember
CO 3	Select reinforcements of polymer matrix composites and its applications.	Evaluate
CO 4	List the Process of Mechanical testing-Static Tests	Analyze
CO 5	Importance of Mechanical testing-Dynamic Tests	Apply

### Course contents:

#### UNIT I MICRO AND CRYSTALSTRUCTUREANALYSIS

10

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers–Microstructure of Engineering Materials Elements of Crystallography – X-ray Diffraction – Bragg’s law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

#### UNIT II ELECTRON MICROSCOPY

9

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications- Atomic Force Microscopy- Construction & working of AFM - Applications .

#### UNIT III CHEMICAL AND THERMAL ANALYSIS

9

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravity metric Analysis (TGA)

**UNITIV MECHANICAL TESTING –STATIC TESTS**

8

Hardness– Brinell, Vickers, Rockwell and Micro Hardness Test–Tensile Test–Stress–Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

**UNITV MECHANICAL TESTING –DYNAMIC TESTS**

9

Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests- modal analysis - Applications of Dynamic Tests.

**TOTAL: 45 PERIODS****REFERENCES:**

1. ASM Hand book-Materials characterization, Vol – 10,2004.
2. Cullity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001.
3. Davis J. R., Tensile Testing, 2nd Edition, ASM International, 2004.
4. Davis, H.E., Hauck G. & Troxell G.E., The Testing of engineering Materials, (4th Edition), McGraw Hill, College Divn., 1982.
5. Dieter G.E., Mechanical Metallurgy, (3rd Edition), ISBN: 0070168938, McGraw Hill, 1988.
6. Goldsten,I.J., Dale.E., Echin.N.P.& Joy D.C., Scanning Electron Microscopy & X ray- Micro Analysis, (2nd Edition), ISBN – 0306441756, Plenum Publishing Corp.,2000.
7. Grundy P.J. and Jones G.A., Electron Microscopy in the Study of Materials, Edward Arnold Limited, 1976.
8. Morita.S, Wiesendanger.R, and Meyer.E, “Non-contact Atomic Force Microscopy” Springer, 2002,
9. Newby J., Metals Hand Book- Metallography & Micro Structures, (9th Edition), ASM International, 1989.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3						2	2	2			3	1	
CO2	3	3						2	2	2			3	1	
CO3	3	3						2	2	2			3	1	
CO4	3	3						2	2	2			3	1	
CO5	3	3						2	2	2			3	1	
	<b>3</b>	<b>High</b>				<b>2</b>	<b>Medium</b>					<b>1</b>	<b>Low</b>		

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PTEE17	ALTERNATIVE FUELS FOR IC ENGINES	L	T	P	C
		3	0	0	3
Nature of Course	Professional elective				
Pre requisites	Fundamental of IC Engines				

**Course Objectives**

1. To understanding of the engineering issues and perspectives affecting fuel and engine development
2. To examine future trends and development, including hydrogen as an internal combustion engine fuel.
3. To explore further fuel specification and performance requirements for advanced combustion Systems.
4. To understand the various alternative fuel options available for conventional fuels and their performance and emission characteristics.
5. To classify the combustion in spark compression ignition by gaseous fuels

**Course Outcomes**

On successful completion of this course the student will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Solve a problem oriented in depth knowledge of Alternate fuel and energy system	Apply
CO2.	Identify the combustion in spark ignition by liquid fuels	Understand
CO3.	Inspect the combustion in spark compression ignition by liquid fuels	Analyze
CO4.	Measure the combustion in spark ignition by gaseous fuels	Evaluate
CO5.	Classify the combustion in spark compression ignition by gaseous fuels	Understand

**Course contents:****UNIT I INTRODUCTION****12**

Availability, Suitability, Properties, Merits and Demerits of Potential Alternative Fuels – Ethanol, Methanol, Diethyl ether, Dimethyl ether, Hydrogen, Liquefied Petroleum Gas, Natural Gas, Bio- gas and Bio-diesel.

**UNIT II LIQUID FUELS FOR S.I.ENGINES****9**

Requirements, Utilisation techniques – Blends, Neat form, Reformed Fuels, Storage and Safety, Performance and Emission Characteristics

**UNIT III LIQUID FUELS FOR C.I.ENGINES****8**

Requirements, Utilisation techniques - Blends, Neat fuels, Reformed fuels, Emulsions, Dual fuelling, Ignition accelerators and Additives, Performance and emission characteristics.

**UNIT IV GASEOUS FUELS FOR S.I.ENGINES****8**

Hydrogen, Compressed Natural gas, Liquefied Petroleum gas, and Bio gas in SI engines – Safety Precautions – Engine performance and emissions.

**UNIT V GASEOUS FUELS FOR C.I.ENGINES****8**

Hydrogen, Biogas, Liquefied Petroleum gas, Compressed Natural gas in CI engines. Dual fuelling, Performance and emission characteristics.

**TOTAL = 45 PERIODS**

## REFERENCES

1. Alcohols as motor fuels progress in technology - Series No.19 - SAE Publication USE, 1980.
2. Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications, 1990.
3. Maheswar Dayal, Energy today a tomorrow - I and B, Horishr India, 1982.
4. Osamu Hirao and RichardK. Pefley, Present and Future Automotive Fuels, John Wiley andSons, 1988.
5. RichardL. Bechfold – Alternative Fuels Guide Book-SAE International Warrendale, 1997.
6. Roger F. Haycock and John E Hillier., Automotive Lubricants Reference Book, Second Edition, SAE International Publications, 2004.
7. Sharma SP, Mohan Chander, Fuels & Combustion, Tata McGraw Hill, 1984.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)																
COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO1	3					2	1							3	1	
CO2	3					2	1							3	1	
CO3	3					2	1							3	1	
CO4	3					2	1							3	1	
CO5	3					2	1							3	1	
	3	High				2	Medium					1	Low			

Assessment	Marks	Weightage	Marks	IAE Marks	FE	Total Marks
IAE – I	50	7.5	25	40	60	100
IAE – II	50	7.5				
IAE – III	50	10				
Quiz/Presentation/Tutorial	10	5	15			
video presentation/Assignment	10	5				
Attendance	10	5				

20PEE301	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTIES RIGHTS	L	T	P	C
		3	0	0	3
Nature of course	Professional core				
Pre requisites	Nil				

### Course Objectives

The course is intended to

1. Impart knowledge and skills required for research problem formulation
2. Identify the relevant literatures for research
3. Develop skills on technical paper writing / presentation without violating professional ethics
4. Acquire knowledge on IPR and patents.
5. Gain knowledge on patent rights and Patent information database.

### Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Identify and formulate research problem	Apply
CO 2	Concentrate on literatures related to research problem.	Understand
CO 3	Possess the ability to write a standard technical paper and presentation.	Apply
CO 4	Find the correct procedure for applying patents	Apply
CO 5	Become well versed on patent rights, licensing and transfer of technology.	Understand

### Course Contents

#### Unit – I Research Problem Formulation

9

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.

#### Unit – II Literature Review

9

Effective literature studies approaches, analysis, plagiarism, and research ethics.

#### Unit – III Technical Writing /Presentation

9

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, Latex Programming ,a presentation and assessment by a review committee.

#### Unit – IV Introduction to Intellectual Property Rights (Ipr)

9

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, Research Hypothesis, Innovation, patenting development, Citation, International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

#### Unit – V Intellectual Property Rights (Ipr)

9

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.Traditional knowledge Case Studies, IPR and IITs.

**Total : 45 Periods**

Passed in the Board of Studies Meeting

  
CHAIRMAN - BOARD OF STUDIES

Approved in Academic Council Meeting

**Reference Books**

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3			3	3		2				3		2	
CO 2	3	3			3	3		2				3		2	
CO 3	3	3			3	3		2				3		2	
CO 4	3	3			3	3		2				3		2	
CO 5	3	3			3	3		2				3		2	
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	Assessment Component	Marks	Total marks
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	Internal Assessment Examinations			Final Examination (60)
	IAE – I (7.5)	IAE – II (7.5)	IAE – III (10)	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				



<b>20PTE302</b>	<b>PROJECT WORK PHASE - I</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>12</b>	<b>6</b>
<b>Nature of course</b>	Employability Enhancement Course				
<b>Pre requisites</b>	Concepts of Research Methodology				

### Course Objectives

The course is intended to

1. Identify a specific problem for the current structural needs of the society.
2. Collect information related to the same through detailed review of literature.
3. Develop the methodology to solve the identified problem
4. Review the methodology and comparing its merits and demerits.
5. Experimental work related to the methodology which includes basic concepts , basic tests etc.,

<b>Course Outcomes</b>		
On successful completion of the course, students will be able to		
<b>CO. No</b>	<b>Course Outcome</b>	<b>Bloom's Level</b>
CO 1	Identify and formulate research problem	Apply
CO 2	Concentrate on literatures related to research problem.	Understand
CO 3	Possess the ability to write a standard technical paper and presentation.	Apply
CO 4	Find the correct procedure for applying patents	Apply
CO 5	Become well versed on patent rights, licensing and transfer of technology.	Understand

### Course Contents

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

**Total : 180 Periods**

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 2	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
	3	High				2	Medium					1	Low		

	Continuous Assessment [50 marks]						Final Viva Voce Examination [50 marks]
	Review I [10]	Review II [10]	Review III [10]	Publication [10]	Report [10 Marks]	Total [50]	
<b>Marks</b>	100	100	100	10	10	50	50

<b>20PTEE21</b>	<b>ADVANCED POWER PLANT ENGINEERING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Nature of course</b>	Professional Elective				
<b>Pre requisites</b>	Courses on Thermodynamics, Thermal Engineering				

### Course Objectives

The course is intended to

1. Provide the knowledge on various power plants and its sub systems.
2. Develop skills in finding the performance of a gas cooled reactor and all other power plants.
3. Explain advances in nuclear and MHD power plants
4. Understand the environmental issues related to the power plants.
5. Explain economic analysis of power plants

### Course Outcomes

On successful completion of the course, students will be able to

<b>CO. No</b>	<b>Course Outcome</b>	<b>Bloom's Level</b>
CO 1	Choose the components of power plants using thermodynamic analysis to predict the performance of the power plants.	Analyze
CO 2	Identify the various components in diesel and gas power plants.	Apply
CO 3	Propose probable designs of hydro and nuclear power plants for a particular geographic region.	Analyze
CO 4	Select the specific areas of application of non conventional power generation	Apply
CO 5	Estimate the capital cost and operating costs of a power plant.	Evaluate

### Course Contents

#### Unit – I Advanced Power Cycles

9

Cogeneration systems – topping & bottoming cycles - Performance indices of cogeneration systems – Heat to power ratio - Thermodynamic performance of steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems- Binary Cycle - Combined cycle – IGCC – AFBC / PFBC cycles – Thermionic steam power plant. MHD – Open cycle and closed cycle- Hybrid MHD & steam power plants.

#### Unit – II Diesel Engine and Gas Turbine Power Plants

9

**Diesel Power Plant:** Essential components of diesel power plant, Operation of diesel power plant, Plant layout with auxiliaries.

**Gas Turbine Plant:** Requirements, Functions, Classification, Construction, and Layout with auxiliaries.

#### Unit – III Hydro Electric and Nuclear Power Plants

9

**Hydro Electric Power Plant:** Selection of site for power plant, Typical layouts, Elements of plant, Classification of dams, Spill ways, Surge tank, Draft tube, Classification of Hydroelectric power plants, Hydrology, Hydrological cycle, Hydrographs;

**Nuclear Power Plants:** Requirements, Functions, Nuclear fuel, Breeding and Fertile materials, Nuclear reactor, Reactor operation, Types of Reactors - Pressurized water reactor, Boiling water reactor, Sodium-Graphite reactor, Fast breeder reactor, Homogeneous reactor, Gas cooled reactor.

**Unit – IV Non Conventional Power Generation and Direct Energy Conversion Systems**

9

**Non-Conventional Power Generation:** Solar, Wind, Tidal, Ocean energy conversion, Geothermal, and biogas power plants.

**Direct energy conversion systems:** Thermoelectric conversion system, Thermionic conversion system, Photovoltaic power systems, Magneto Hydrodynamic systems, Electrostatic mechanical generators, Electro gas-dynamic generators, and Fuel cells

**Unit – V Power Plant Economics and Pollutions**

9

Load curves, Load duration curve, Definitions of connected load, Maximum demand, Demand factor, Load factor, Plant capacity factor, Plant use factor, Diversity factor, Cost Analysis, Power plant pollution- Pollutions from Thermal and Nuclear Power plants. Emission calculation and carbon credit.

**Total : 45 Periods**
**TEXT BOOKS:**

1. R.K.Rajput, A Text Book of Power Plant Engineering, Laxmi Publications, 3<sup>rd</sup> edition, 2014.
2. Arora and S. Domkundwar, A Course in Power Plant Engineering, Dhanpat Rai and Co, 3<sup>rd</sup> Edition, 2012.

**REFERENCE BOOKS:**

1. P.K.Nag, Power Plant Engineering, TMH, 2<sup>nd</sup> edition, 2006.
2. K.K Ramalingam, Power plant Engineering, Scitech Publishers. 2<sup>nd</sup> edition, 2010.
3. Dr.P.C Sharma, power plant engineering, Sk Kataria and sons publishers, 8<sup>th</sup> Edition, 2011.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	1										1	2	
CO 2	2	3	1										1	2	
CO 3	1	3	1										1	2	
CO 4	2	3	1										1	2	
CO 5	3	2	1										1	2	
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	Assessment Component	Marks	Total marks
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

<b>Summative Assessment</b>				
<b>Bloom's Category</b>	<b>Internal Assessment Examinations</b>			<b>Final Examination (60)</b>
	<b>IAE – I (7.5)</b>	<b>IAE – II (7.5)</b>	<b>IAE – III (10)</b>	
Remember			10	10
Understand	10	10		20
Apply	20	20		30
Analyze	20	20	20	30
Evaluate			20	10
Create				

<b>20PTEE23</b>	<b>COGENERATION AND WASTE HEAT RECOVERY SYSTEMS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Nature of course</b>	Professional Elective				
<b>Pre requisites</b>	Basic knowledge of power plant engineering				

### Course Objectives

The course is intended to

1. Gain fundamental knowledge in energy generation, heat transfer in thermal engineering.
2. Analyze the basic energy generation cycles.
3. Detail about the concept of cogeneration its types and probable areas of applications.
4. Study the significance of waste heat recovery systems and carry out its economic analysis.
5. Reduce the impact global warming for betterment of living things to serve healthy life.

### Course Outcomes

On successful completion of the course, students will be able to

<b>CO. No</b>	<b>Course Outcome</b>	<b>Bloom's Level</b>
CO 1	Demonstrate the knowledge in energy generation and cogeneration technologies	Understand
CO 2	Apply the energy generation principle and for various application	Apply
CO 3	Choose the significance of waste heat recovery systems	Apply
CO 4	Classify the waste heat recovery for probable areas of applications,	Analyze
CO 5	Analysis the economics in cogeneration, waste heat recovery systems and reduce the impact global warming	Analyze

### Course Contents

#### Unit – I Cogeneration and Technologies

9

Introduction - Principles of Thermodynamics - Combined Cycles - Topping - Bottoming - Organic Rankine Cycles. Advantages of Cogeneration Technology- Steam turbine cogenerations systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: fuel cell, Stirling engines etc.,

#### Unit – II Issues and Cogeneration Application

9

Issues -Cogeneration plants electrical interconnection issues – utility and cogeneration plant interconnection issues. Cogeneration Application in various Industries like Cement, Sugar Mill, Paper Mill etc. Sizing of Waste Heat Boilers - Performance Calculations - Part Load Characteristics, Selection of Cogeneration Technologies.

#### Unit – III Waste Heat Recovery

9

Introduction - Principles of Thermodynamics and Second Law - Sources of Waste Heat Recovery - Diesel Engines and Power Plant etc. Systems-recuperators – Regenerators – economizers – plate heat exchangers – thermic fluid heaters – Waste heat boilers – classification, location, service conditions, design Considerations – fluidized bed heat exchangers – heat pipe exchangers – heat pumps – sorption systems.

#### Unit – IV Waste Heat Recovery Applications

9

Applications in Industries - Fluidized Bed Heat Exchangers - Heat Pipe Exchangers - Heat Pumps - Thermic Fluid Heaters Selection of Waste Heat Recovery Technologies, Selection criteria for waste heat recovery technologies.

**Unit – V Economic Analysis and Environmental Considerations****9**

Economic Analysis- Investment cost - economic concept - measure of economic performance – procedure for economic analysis – examples – Procedure for optimized system selection and design load curves – sensitivity analysis – regulatory and financial frame work for cogeneration and waste heat recovery systems. Environmental considerations for Cogeneration and Waste Heat Recovery - Pollution

**Total : 45 Periods****Reference Books:**

1. Charles H. Butler, Cogeneration, McGraw Hill Book Co., 1984.
2. De Nevers, Noel, Air Pollution Control Engineering, McGraw Hill, New York, 1995.
3. Sengupta Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.
4. Energy Cogeneration Hand book, George Polimveros, Industrial Press Inc, New yark 1982.
5. Horlock JH., Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford,1987.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	1										1	2	
CO 2		3				2	1						1	2	
CO 3	3	2	1										1	2	
CO 4	3					1	2						1	2	
CO 5		3				1	2						1	2	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	Assessment Component	Marks	Total marks
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	



<b>Summative Assessment</b>				
<b>Bloom's Category</b>	<b>Internal Assessment Examinations</b>			<b>Final Examination (60)</b>
	<b>IAE – I (7.5)</b>	<b>IAE – II (7.5)</b>	<b>IAE – III (10)</b>	
Remember	10	10	10	20
Understand	30	20	10	20
Apply	20	20		30
Analyze			30	30
Evaluate				
Create				

**SEMESTER- IV**

<b>20PTE401</b>	<b>PROJECT WORK PHASE - II</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>24</b>	<b>12</b>
<b>Nature of course</b>	Employability Enhancement Course				
<b>Pre requisites</b>	Knowledge in Thermal Engineering				

**Course Objectives**

The course is intended to

1. Solve the identified problem based on the formulated methodology
2. Develop skills to analyze the problem related to area.
3. Continue the trials until the expected positive results are obtained
4. Preparation of preliminary report and discussion on test results
5. Arrive at conclusion and suggestion for future works.

**Course Outcomes**

On successful completion of the course, students will be able to

<b>CO. No</b>	<b>Course Outcome</b>	<b>Bloom's Level</b>
CO 1	Select different software/ computational/analytical tools.	Select
CO 2	Design and develop an experimental set up/ equipment/test rig.	Creating
CO 3	Conduct tests on existing setup with equipments and draw logical results.	Analyzing
CO 4	Conclude the results with suitable remarks and suggestion for further extension of work.	Evaluating
CO 5	Present their topic of study to the engineering community.	Apply

**Course Contents**

The student should continue the phase I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report and the viva-voce examination by a panel of examiners including one external examiner.

**Total : 360 Periods**

<b>Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)</b>															
<b>COs</b>	<b>POs</b>												<b>PSOs</b>		
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>1</b>	<b>2</b>	<b>3</b>
CO 1	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 2	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	2	3	
	3	High				2	Medium				1	Low			

Passed in the Board of Studies Meeting

*N. Natarajan*  
CHAIRMAN - BOARD OF STUDIES

Approved in Academic Council Meeting

	Continuous Assessment [50 marks]						Final Viva Voce Examination  [50 marks]
	Review I [10]	Review II [10]	Review III [10]	Publication  [10]	Report  [10 Marks]	Total  [50]	
<b>Marks</b>	100	100	100	10	10	50	50