CURRICULUM AND SYLLABUS (R2015)
CHOICE BASED CREDIT SYSTEM
M.TECH – THERMAL ENGINEERING
(FULL TIME)
I – IV SEMESTERS

SEMESTER – I							
S.NO.	**CODE**	**CATEGORY**	**SUBJECT NAME**	**L**	**T**	**P**	**C**
1	MMA109	PM	Mathematical Methods	3	2	0	4
2	MME101	PC	Fuels, Combustion And Emission Control	3	0	0	3
3	MME102	PC	Advanced Fluid Mechanics	3	0	0	3
4	MME103	PC	Advanced Heat Transfer	3	0	0	3
5	MME104	PC	Analysis Of Thermal Power Cycles	3	0	0	3
6	MME1E1	PE	Professional Elective – I	3	0	0	3
7	MME1L1	PC	Thermal Laboratory	0	0	4	2

TOTAL CONTACT HOURS-22 **TOTAL CREDIT: 21**

SEMESTER – II							
S.NO.	**CODE**	**CATEGORY**	**SUBJECT NAME**	**L**	**T**	**P**	**C**
1	MME201	PC	Fluid Mechanics of Turbo Machines	3	0	0	3
2	MME202	PC	Instrumentation	4	0	0	4
3	MME203	PC	Computational Fluid Dynamics	3	0	0	3
4	MME204	PC	Advanced IC Engines	3	0	0	3
5	MME2E2	PE	Professional Elective – II	3	0	0	3
6	MME2E3	PE	Professional Elective – III	3	0	0	3
7	MME2L1	PC	Heat Transfer Laboratory	0	0	4	2

TOTAL CONTACT HOURS-23 **TOTAL CREDIT: 21**

SEMESTER – III							
S.NO.	CODE	**CATEGORY**	SUBJECT NAME	L	T	P	C
1	MME301	PC	Advanced Refrigeration And Air Conditioning Engg..	3	0	0	3
2	MME302	PC	Environmental Pollution Control	3	0	0	3
3	MME3E4	OE	Open Elective	3	0	0	3
4	MME3P1	PR	Project Work Phase I	0	0	12	6

TOTAL CONTACT HOURS-21 **TOTAL CREDIT: 15**

SEMESTER – IV							
S.NO.	CODE	**CATEGORY**	SUBJECT NAME	L	T	P	C
1	MME4P2	PR	Project Work Phase II	0	0	24	12

TOTAL CONTACT HOURS-24 **TOTAL CREDIT: 12**

TOTAL PROGRAMME CREDITS: 69

SUMMARY OF CURRICULUM STRUCTURE AND CREDIT & CONTACT HOUR DISTRIBUTION

S.NO	Sub Area	Credit As per Semester				No. of Credit	% of credit
		I	II	III	IV		
1	Professional Mathematics (PM)	4	-	-	-	4	5.80%
2	Professional Core (PC)	14	15	6	-	35	50.72%
3	Professional Electives (PE)	3	6	-	-	9	13.04%
4	Open Electives (OE)	-	-	3	-	3	4.35%
5	Project Work, Seminar, Internship, etc. (PR)	-	-	6	12	18	26.09%
	Total Credit	21	21	15	12	69	100%
	Total Contact Hour	22	23	21	24	90	

LIST OF ELECTIVES
Professional Elective –I

S.NO.	CODE	SUBJECT NAME	L	T	P	C
1	MME E2	Energy Conservation, Management And Auditing	3	0	0	3

2	MME E6	Heat Transfer Equipment Design	3	0	0	3
3	MME E12	New And Renewable Sources Of Energy	3	0	0	3
4	MMD 203	Design Of Pressure Vessels And Piping	3	0	0	3

Professional Elective –II

S.NO.	CODE	SUBJECT NAME	L	T	P	C
1	MME E5	Boiler Auxiliaries And Performance Evaluation	3	0	0	3
2	MME E10	Frontier Materials	3	0	0	3
3	MME E11	Combustion Engineering	3	0	0	3
4	MME E13	Nuclear Engineering	3	0	0	3

Professional Elective –III

S.NO.	CODE	SUBJECT NAME	L	T	P	C
1	MME E7	Installation Testing And Operation Of Boilers	3	0	0	3
2	MME E9	Non Destructive Testing And Failure Analysis	3	0	0	3
3	MME E14	Design And Analysis Of Turbo Machines	3	0	0	3
4	MME E15	Advanced Thermal Storage Technologies	3	0	0	3

Open Elective

S.NO.	CODE	SUBJECT NAME	L	T	P	C
1	MAE002	Robotics	3	0	0	3
2	MCS157	System Modeling And Simulation	3	0	0	3
3	PCD 005	Mechatronics	3	0	0	3
4	MST070	Research Methodology	3	0	0	3
5	MMD 007	Advanced Material Science And Failure Analysis In Mechanical Design	3	0	0	3

SEMESTER I

Course Code MMA 109	Course Name: **Mathematical Methods**	L	T	P	C
	Total Contact Hours: 60	3	2	0	4
	Prerequisite: Engineering Mathematics I, Engineering Mathematics II, Engineering Mathematics				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:
To equip students with adequate knowledge of mathematical methods to formulate in engineering and solve them analytically and numerically

COURSE OUTCOMES (COs)

CO1	To Understand the principle of calculus of variations and apply to mechanical problems
CO2	To analyze various methods of variational problems applicable to Engineers
CO3	To Analyze the various integral equations applicable to engineers
CO4	To evaluate various partial differential equations useful for thermal engineers.
CO5	To analyze finite element methods and application of shape function to fluid flow a heat transfer problems

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	A	b	c	D	e
2	CO1	M	M		H	
	CO2	L		M	H	M
	CO3		M		H	
	CO4				H	
	CO5	L			H	M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
		√				
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

OBJECTIVE:
To equip students with adequate knowledge of mathematical methods to formulate in engineering and solve them analytically and numerically

UNIT-1 **12**
Calculus of variations - Euler's equation - Variational problems in parametric form - Natural

Boundary condition – Conditional Extremum - Isoperimetric problems.

UNIT-2 **12**

Direct methods in Variational Problems - Euler's finite difference method - Rayleigh -Ritz Method - Galerkin's method - Kantorovich’s method.

UNIT-3 **12**

Integral equations - Conversion of BVP to integral equations using Green’s Function - Fredholm Equation with separable kernels – Solution of Fredholm and Volterra equations by the method of Successive approximations.

UNIT-4 **12**

Finite difference scheme for elliptic, parabolic, and hyperbolic partial differential equations.

UNIT-5 **12**

Introduction to Finite Element Method - Rules for forming interpolation functions - Shape Functions Application to fluid flow and heat transfer problems.

Text book

1. GREWAL, B.S. , Higher Engineering Mathematics, Khanna Publishers.

References.

1. DESAI, C.S., and ABEL, J. P., Introduction to Finite Element Method, Van Nostrand Reinhold.
2. ELSEGOLTS, L., Differential Equations and the Calculus of Variations, Mir Publishers.
3. HILDEBRAND, P.B., Method of Applied Mathematics, Prentice Hall.
4. VENKATARAMAN, M. K., Higher Mathematics for Engineering and Science, National Publishing Company.

Total no of periods: 60

Course Code MME 101	**Course Name: Fuels, Combustion and Emission Control**	**L**	**T**	**P**	**C**
	Total Contact Hours: 45	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:

The course is intended to

- Provide Students with Knowledge of Fuel Quantity and Engine Technology Effects on Emissions.
- Understand The Combustion Phenomena.
- Understand The Concept of Laminar and Turbulent Flame Propagation.
- Understand About Different Methods to Reduce Air Pollution

COURSE OUTCOMES (COs)

CO1	Have the knowledge of fuel thermo-chemistry and fuel quality effects on emissions, engine technologies, engine combustion-related emissions and control technologies
CO2	Extend their knowledge of fuels and engines to different situations of engineering context and professional practice.

CO3	Understand combustion in spark ignition and diesel engines.
CO4	To identify the nature and extent of the problem of pollutant formation and Control in internal combustion engines government legislation
CO5	To understand the principal of combustion.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	A	b	c	D	E
2	CO1	H	M	L	M	H
	CO2	H				M
	CO3	H	M	M	L	
	CO4	H				
	CO5					
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 BASICS **9**

Types of fuels and their properties - Coal characterization - Combustion chemistry - Stoichiometry Heat of reaction - Calorific value - Adiabatic flame temperature - Equilibrium - Mass transfer.

UNIT-2 COMBUSTION MECHANISMS FOR LAMINAR FLOW **9**

Chemical kinetics – Important chemical mechanisms – Simplified conservation equations for Reactingflows– Laminar premixed flames - Simplified analysis.

UNIT-3 TURBULENT FLOW **9**

Factors influencing flame velocity and thickness flame stabilization – Diffusion flames – Introduction to turbulent flames.

UNIT-4 COMBUSTION OF SOLID FUELS **9**

FBC – Different types of FBCs – Models for droplet and Carbon particle combustion.

UNIT-5 EMISSION CONTROL **9**

Emissions - Emission index - Corrected concentrations - Control of emissions for premixed and non-premixed combustion.

Text book:

Turns, S.R., *An Introduction to Combustion - Concepts and Applications, 3rd* ed., McGraw-Hill, 2011.

Referencves:

1. Sharma, S.P. and Mohan, c., *Fuels and Combustion,* Tata McGraw-Hill, 1984.

2. Sarkar.S., *Fuels and Combustion*, Orient Longman, 2009.

Total no of periods: 45

Course Code MME 103	Course Name: Advanced Fluid Mechanics	L	T	P	C
	Total Contact Hours: 45	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:

The course is intended to

- Establish an understanding of the fundamental concepts of fluid mechanics.
- Understand and apply the potential flow equations to basic flows.
- Understand and apply the differential equations of fluid mechanics including the ability to apply and understand the impact of assumptions made in the analysis.
- Understand the boundary layer concepts with respect to fluid flow
- Understand and apply the compressible flow equations

COURSE OUTCOMES (COs)

CO1	Ascertain basic concepts in the fluid mechanics
CO2	Analyze practical problems of fluid flow
CO3	Design compressible flow components used in Turbo machines and air- conditioning
CO4	Understand the performance of fluid flow devices in laminar and Turbulent flows
CO5	Apply the concepts in the analysis of fluid flow problems

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	A	b	c	d	e
2	CO1	H	H	M	H	H
	CO2	H	H	H	M	H
	CO3	M	H	M	M	H
	CO4	H	M	H	M	H
	CO5	M	M	M	M	M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 REVIEW OF BASIC CONCEPTS **9**

Review of Basic concepts- Reynolds's transport theorem, Fluid kinematics – Physical Conservation laws – Integral and differential formulations.

UNIT-2 FLOW ANALYSIS **9**

Navier-Stokes and energy equations – Dimensionless forms and dimensionless numbers – Solution of Navier-Stokes equations.

UNIT-3 LAMINAR FLOW **9**

Two-dimensional Potential flows - Different types of flow patterns. Boundary layer theory - Blasius solution - Momentum integral approach.

UNIT-4 TURBULENT FLOW **9**

Turbulent flows– Reynolds equation –Prandtl and von Karman hypothesis- Universal velocity Profile near a wall- flow through pipes

UNIT-5 BOUNDRY LAYER **9**

Boundary layer concept- Boundary layer thickness- prandd's equations-blassius solution-skin Friction coefficient.

Text book:

Yunus.A.CENGAL.,*fluid mechanics,2nd edition.*,McGraw-Hill,*2010*

References:

1. Currie, LG., *Fundamental Mechanics of Fluids, 4th*ed., CRC Press, 2012.
2. White, P.M., *Viscous Fluid Flow, 2nd* ed., McGraw-Hill, 1991.
3. Ockendon, H. and Ockendon, J., *Viscous Flow,* Cambridge Uni. Press,
1995.

Total no of periods: 45

Course Code MME 105	**Course Name: Advanced Heat Transfer**	**L**	**T**	**P**	**C**
	Total Contact Hours: 45	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:

The course is intended to

- Impart the advances knowledge of heat transfer.
- Get analytical solutions for 2-D steady and transient heat conduction problems.
- Deep understanding on the governing equations for convection heat transfer; knowing the dimensionless parameters (influencing the convection performance).
- Aware of turbulence concept and modeling.
- Apply the concept of natural convection for electronic cooling, HVAC etc.

COURSE OUTCOMES (COs)

CO1	Understand both the physics and the mathematical treatment of the advanced topics pertaining to the modes of heat transfer
CO2	Apply principles of heat transfer to develop mathematical models for uniform and Non-uniform fins.
CO3	Employ mathematical functions and heat conduction charts in tackling two- Dimensional a three-dimensional heat conduction problems
CO4	Analyze free and forced convection problems involving complex geometries with proper boundary conditions

CO5	Apply the concepts of radiation heat transfer for enclosure analysis					
Mapping of Course Outcomes with Program outcomes (POs) (H/M/L indicates strength of correlation) H-High, M-Medium, L-Low						
1	COs/Pos	A	b	c	d	E
2	CO1	M	H	-	H	
	CO2	H		-		L
	CO3	M	M	M	M	
	CO4	H		-		L
	CO5	M	H	-		
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1TRANSIENT HEAT CONDUCTION **9**

Transient heat conduction - Exact solution - Use of Heisler and Grober chart-Integrated method.

UNIT-2 STEADY STATE HEAT TRANSFER **9**

Extended surfaces - Steady state analysis and optimization-Radial fins of rectangular and hyperbolic profiles- longitudinal fin of rectangular profile radiating to free space.

UNIT-3 CONVECTION **9**

Thermal boundary layers - Momentum and energy equations -Internal and external flows- Forced convection over cylinders, spheres and bank of tubes.

UNIT-4 MASS TRANSFER **9**

Heat transfer with phase change – condensation and boiling heat transfer- Heat transfer in condensation, Effect of non-condensable gases in condensing equipments. Flow boiling correlations.

UNIT-5 RADIATION **9**

Radiative exchange in furnaces-Radiation characteristics of particle systems, Thermal radiation ofa luminous fuel oil and gas- Soot flame- overall heat transfer in furnaces.

Text book:

Ozisik, M.N., *Heat Transfer- A Basic Approach,* McGraw-Hill, 2007.

References:

1. Incropera, P.P. and Dewitt, D.P., *Fundamentals of Heat and Mass Transfer*, *5th* ed., John W iley, 2002.
2. Kakac, S. and Yener, Y., *Convective Heat Transfer,* CRC Press, 1995.

3. Kraus, A.D., Aziz, A., and Welty, J., *Extended Surface Heat Transfer,* John Wiley, 2001.

Total no of periods: 45

Course Code **MME 107**	**Course Name: Analysis of Thermal Power Cycles**	**L**	**T**	**P**	**C**
	Total Contact Hours: 45	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:

The course is intended to

- Provide analytical methods for the determination of the direction of processes from the first and second laws of thermodynamics and to Introduce methods in using equations of potentials, availability, and excergy for thermodynamic analysis
- Gain the knowledge on non-reactive mixture properties , Psychometric Mixture properties andpsychometrics chart and Air conditioning processes
- Develop the ability of analyzing vapor and Gas power cycles
- Provide in depth knowledge of Direct Energy Conversion of Fuel Cells , Thermo electric energy
- Thermionic power generation ,Thermodynamic devices Magneto Hydrodynamic Generations and Photo voltaic cells
- Develop communication and teamwork skills in the collaborative course project

COURSE OUTCOMES (COs)

CO1	Gain the analytical methods for the determination of the direction of processes fror the first and second laws of thermodynamics and to carry out the thermodynamic analysis using equations of potentials, availability, and excergy
CO2	Apply the knowledge of adiabatic flame temperature in the design of combustion devices.
CO3	Identify the phenomenon of flame stabilization in laminar and turbulent flames
CO4	Analyze the pollution formation mechanisms in combustion of solid, liquid and gaseous fuels.
CO5	Apply the knowledge of Direct Energy Conversion of Fuel Cells , Thermo electric energy, Thermionic power generation ,Thermodynamic devices Magneto Hydrodynamic Generations and Photo voltaic cells

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	D	e
2	CO1	H	M	H	M	M
	CO2	M	H		H	
	CO3	H		M		M
	CO4	M	M	M	M	
	CO5	M		L		M

3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 VAPOUR POWER CYCLES **9**

Steam power plant cycle –Rankin cycle – Reheat cycle – Regenerative cycle with one and more feed heaters – Types of feed heaters – Open and closed types – Steam traps types.

UNIT-2 COMBINED CYCLES **9**

Cogeneration - Condensing turbines - Combined heat and power - Combined cycles - Brayton cycleRankine cycle combinations - Binary vapour cycle.

UNIT-3 AIR STANDARD CYCLES **9**

Air standard cycles – Cycles with variable specific heat – fuel air cycle – Deviation from actual cycle.

UNIT-4 AIR POWER CYCLES **9**

Bray ton cycle - Open cycle gas turbine - Closed cycle gas turbine - Regeneration - Inter cooling and reheating between stages.

UNIT-5 REFRIGERATION CYCLES **9**

Refrigeration Cycles - Vapor compression cycles - Cascade system - Vapour absorption cycles -GAX Cycle.

Text book:

Nag. P.K., *Engineering Thermodynamics, 3rd* ed., Tata McGraw-Hill, 2005.

References:

1. Culp, R., *Principles of Energy Conversion,* McGraw-Hill, 2000.
2. Nag. P.K., *Power Plant Engineering, 2nd*Tata McGraw-Hill, 2002.
3.Arora, C.P., *Refrigeration and Air Conditioning, 2nd* ed., Tata McGraw-Hill, 2004.

Total no of periods: 45

Course Code MME 1L1	**Course Name: Thermal Laboratory**	**L**	**T**	**P**	**C**
	Total Contact Hours: 45	0	0	4	2
	Prerequisite:				

	Course Designed by : Department of Mechanical Engineering

OBJECTIVES:
The lab is mainly intended to

- Analyze the performance and exhaust emissions of an IC engine by conducting the performance test on IC Engines.
- Evaluate the performance of the Vapor compression and Air conditioning units
- Analyze the flame propagation velocity of the gaseous fuels

COURSE OUTCOMES (COs)

CO1	Analyze the performance and exhaust emissions of an IC engine
CO2	Evaluate the performance of the Vapor compression and Air conditioning units
CO3	Analyze the flame propagation velocity of the gaseous fuels
CO4	Analyze the pollution formation mechanisms in combustion of solid, liquid and gaseous fuels.
CO5	Apply the knowledge of Direct Energy Conversion of Fuel Cells , Thermo electric energy

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	H	M	-	-	
	CO2	H	H	-	-	
	CO3	H		-	-	H
	CO4	H	M	M	-	
	CO5	H		-	M	M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

Total no of periods: 45

SEMESTER II

Course Code MME 202	Course Name: Fluid Mechanics of Turbo machines	L	T	P	C
	Total Contact Hours: 45	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:

The course is intended to

- Understand the fundamental concepts of turbo machines.
- Apply concepts of fluid mechanics in turbo machines.
- Understand the thermodynamic analysis of steam nozzles and turbines.
- Understand the different types of compressors and evaluating their performances in the form of Velocity triangles.
- Familiarize the basic concepts of gas dynamics and analyze the performance of axial flow gas Turbines.

COURSE OUTCOMES (COs)

CO1	Able to derive the basic equations used for turbo machines
CO2	Will be able to understand the concept of velocity triangles used for performance evaluation of Turbines
CO3	Able to understand the concept of degree of reaction for axial flow compressors
CO4	Will able to understand the basic concepts of gas dynamics
CO5	Analyze the performance of axial flow gas turbines

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	E
2	CO1	M		M	M	H
	CO2	L	M			
	CO3				H	M
	CO4	M	L	H		
	CO5	M			M	M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 2D CASCADES **9**

Introduction and cascades – Two-dimensional cascades – Analysis of cascade forces – Energy losses – Cascade correlation – Off design performance.

UNIT-2POWER GENERATING MACHINES – TURBINES **9**

Power generating machine I - Axial flow turbines- Stage losses and efficiency – Soderberg's correlation – Turbine flow characteristics

UNIT-3 POWER GENERATING MACHINES – COMPRESSORS **9**

Power absorbing machine I - Axial flow compressors – Three dimensional flowin axial turbo machines – theory of radial equilibrium – actuator disc approach – Secondary flows

UNIT-4 POWER GENERATING MACHINES – PUMPS & FANS 9

Power absorbing machine II - Centrifugal pumps, fans, and compressors – slip factor – optimum design of centrifugal compressor inlet choking in a compressor stage.

UNIT-5 POWER GENERATING MACHINES

Power generating machine II - Radial flow turbines, Loss coefficients – off design operating condition – clearance and windage losses 90 deg IFR turbines.

Text book:

1. Csanady, G.T., *Theory of Turbo machines,* McGraw Hill, 1964.

References:

1. Dixon, S.L., *Fluid Mechanics and Thermodynamics of Turbo machinery, 5th* ed., Butterworths Heinemann, 2005.
2. Prithvi Raj, D. and Gopalakrishnan, G., *A Treatise on Turbo machines,* SciTech Publication, 2003.

Total no of periods: 45

Course Code MME 204	Course Name: INSTRUMENTATION	L	T	P	C
	Total Contact Hours: 60	4	0	0	4
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:
The course is intended to

- Educate the student with operating principles and function of measuring instruments used in Engineering and process industries
- Make the student conversant with various working principles of instruments
- Understand and analyze the behavioral characteristics of instruments
- Make the student learn about calibration procedure the instrument
- Educate the student about the fundamental aspects of control; systems and their use in the context of industry applications

COURSE OUTCOMES (COs)

CO1	Making the student conversant with different working principles of various instruments
CO2	Making the student to learn in the transduction of the signals
CO3	Student can be able to analyze the behavior of an instrument in the measurement proce
CO4	Be able to analyze and design an instrumentation system, dealing with the concepts of dynamic range, signal noise ratio, and error budget
CO5	Build, program, calibrate and use a microprocessor-based instrumentation system

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	E
2	CO1	M		L	-	
	CO2		L		-	
	CO3	M		L	-	M
	CO4		M		M	
	CO5	L		M	-	L
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 DISPLACEMENT 12

Generalized instrumentation system – Error theory – Calibration of instruments – Range – Resolution – Span – Linearity, Sensitivity- Signal conditioning systems.

UNIT-2 INSTRUMENTATION SYSTEM 12

Static and dynamic characteristics of instruments zero order, first order, second order instruments.

UNIT-3 ERROR ANALYSIS 12

Error analysis - Uncertainty propagation – Oscilloscope for analysis of dynamic and transient Events.

UNIT-4 MEASUREMENT SYSTEM 12

Principles and analysis of measurement systems used for measurement of flow, power, pressure, And temperature.

UNIT-5 CONTROL SYSTEM 12

Basics of control system - Types of control – proportional control, Derivative control, Integral Control, PID control-Programmable logic controllers.

Text book:

1. Doebelin, E.O., *Measurement Systems - Application and Design, 5th* ed., McGraw-Hill, 2007.

References:

1. Beckwith, T.G., Buck, L., and Marangoni, R.D., *Mechanical Measurements,* Narosa Pub. House, 1987.

2. Hewlett Packard, *Practical Temperature Measurements* - Application Note 290,

1995.Use of oscilloscope for measurement of dynamic parameters - PV diagram of compressors and I engines - Comparison of flow measuring instruments - Measurement of static and dynamic characteristics of instruments.

Total no of periods: 60

Course Code MME 206	Course Name: COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
	Total Contact Hours: 45	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:

The course is intended to

- Understand the basics of computational fluid dynamics (CFD).
- Differentiate between finite difference and finite volume methods applied in CFD.
- Provide the necessary background in discretization methods, accuracy, stability and convergence aspects of numerical solutions.
- Develop an understanding of the capabilities and limitations of various numerical and mathematical models of fluid flow.
- Introduce some of the models required to compute turbulent and incompressible fluid flow problems
- Apply CFD to heat transfer problems

COURSE OUTCOMES (COs)

CO1	Derive the basic governing equations applied for fluid flow problems
CO2	Apply the differential equations to fluid flow problems
CO3	Understand the concept of discretization.
CO4	Solve simple algorithms for incompressible fluid flow
CO5	Apply the basics of CFD to heat transfer problems

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	E
2	CO1	H	M	-	H	M
	CO2	H	H	-	H	
	CO3	M		-	H	H
	CO4	H	M	M		
	CO5	M		-	M	H
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			

4	Approval	37th , 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016

UNIT-1 CLASSIFICATION OF PDE & FDF **9**

Classification of partial differential equations – Discretization methods – finite difference and finite volume formulations –classificatrion of PDES.

UNIT-2ELLIPTICAL EQUATIONS & LINEAR SYSTEMS **9**

Numerical solution of elliptical equations – Linear system of algebraic equations – Iterative solution of system of linear equation.

UNIT-3 MODEL & WAVE EQUATION **9**

Model Equations – Wave equations – Numerical solution of parabolic equations – Stability analysis– Advanced shock capturing schemes.

UNIT-4 CONVECTION HEAT TRANSFER **9**

Solutions of convection - Diffusion equation – Conservative and non-conservative schemes – concept of artificial viscosity and Numerical Diffusion.

UNIT-5 NAVIER-STROKE EQUATION & GRID GENERATION **9**

Navier-Stokes equations and algorithms; Basics of grid generation- Numerical solution of hyperbolic equations - Burgers equation generation.

Text book:

Hoffman, K.A. and Chiang, S.T., *Computational Fluid Dynamics for Engineers,* Engineering Education Systems, 2000.

References:

1. Tannehill, J.c., Anderson, D.A., and Pletcher, R.H., *Computational Fluid Mechanics and Heat Transfer, 3rd*ed., Taylor & Francis, 1997.
2. Peyret, R. and Taylor, T. D., *Computational Methods for Fluid Flow*, Springer- Verlag, 1983.

Total no of periods: 45

Course Code MME 208	**Course Name: ADVANCED IC ENGINES**	**L**	**T**	**P**	**C**
	Total Contact Hours: 45	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:

The course is intended to

- Analyze engine cycles and the factors responsible for making the cycle different from the Ideal cycle.
- Apply principles of thermodynamics, fluid mechanics, and heat transfer to influence the engine's performance. Understand the delay period and fuel injection system
- Become aware of the relevance of environmental and social issues on the design process of internal combustion engines

COURSE OUTCOMES (COs)	
CO1	Analyze engine cycles and the factors responsible for making the cycle different from the Ideal cycle
CO2	Apply principles of thermodynamics, fluid mechanics, and heat transfer to influence th engine's performance
CO3	To Demonstrate the delay period and fuel injection system
CO4	Demonstrate an understanding of the relationships between the design of the IC engine and environmental and social issues
CO5	Analyze problems involving steady state heat conduction in simple geometries

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	D	E
2	CO1	H	H	H	M	H
	CO2	M	M	H	H	
	CO3	H		H		M
	CO4	H	M	H	M	H
	CO5	H	H	H	M	H
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 OPERATING PARAMETERS & THERMO CHEMISTRY **9**

Engine design and operating parameters – Thermo chemistry of fuel air mixtures- properties of working fluids.

UNIT-2 ENGINE CYCLES & CYCLE ANALYSIS **9**

Ideal model of engine cycles – cycle analysis with constant specific heats – Volumetric efficiency– Super charging and Turbo charging

UNIT-3 FUEL INTAKE & INJECTION SYSTEM **9**

Fuel intake systems and combustion in SI and CI engines – Carburetor an fuel injection systems –Squish prechamber engine flows.

UNIT-4 POLLUTANT FORMATION & CONTROL **9**

Pollutant formation and control in IC engines - Types of diesel combustion system – Fuel spray behavior – Ignition delay.

UNIT-5 ENGINE OPERATING CHARATERISTICS **9**

Engine friction and lubrication – measurement of friction – fluid mechanics based multi dimensional models – Engine operating characteristics.

Text book:
1. Heywood, J.B., *Internal Combustion Engine Fundamentals*, McGraw-Hill, 1988.
2. Ganesan, V., *Internal Combustion Engines*, *2nd* ed., Tata McGraw-Hill, 2003.

References:
Taylor, C.P., *The Internal Combustion Engines in Theory and Practice*, Vol-2, MIT press, 1985.

Total no of periods: 45

Course Code MME 2L1	**Course Name: Heat Transfer Laboratory**	**L**	**T**	**P**	**C**
	Total Contact Hours: 45	0	0	4	2
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:
This course is designed to introduce a basic study of the phenomena of heat and mass trans to develop methodologies for solving a wide variety of practical engineering problems, an provide useful information concerning the performance and design of particular systems processes. A knowledge-based design problem requiring the formulations of solid conduc and fluid convection and the technique of numerical computation progressively elucidate different chapters will be assigned and studied in detail. As well, to gain experience designing experiments for thermal systems, the design, fabrication, and experimentation thin film heat flux gage will be attempted as part of laboratory requirements.

COURSE OUTCOMES (COs)

CO1	Understand the basic laws of heat transferandAccount for the consequence of heat transfer in thermal analyses of engineering systems
CO2	Analyze problems involving steady state heat conduction in simple geometries
CO3	Obtain numerical solutions for conduction and radiation heat transfer problems and understand the fundamentals of convective heat transfer process.
CO4	Evaluate heat transfer coefficients for natural convection,forced convection inside ducts,forced convection over exterior surfaces
CO5	Analyze heat exchanger performance by using the method of log mean temperature difference.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	D	E
2	CO1	H	H	-	M	
	CO2	H		-		
	CO3	M		M		
	CO4	H		-		
	CO5	M	H	-		

3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

LIST OF EXPERIMENTS

1. Thermal conductivity of insulating materials
2. Heat transfer through composite wall
3. Heat transfer from fins-natural and forced convection
4. Test on Pinfin apparatus
5. Heat balance test on twin cylinder 4 stroke diesel engine

Total no of periods: 45

SEMESTER III

Course Code MME 302	**Course Name: ADVANCED REFRIGERATION AND AIR CONDITIONING**	**L**	**T**	**P**	**C**
	Total Contact Hours: 45	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:

The course is intended to

- Familiarize students with the terminologies associated with refrigeration & air conditioning
- Cover the basic principles of psychometric and applied psychometrics
- Familiarize students with system analysis
- Familiarize students with load calculations and elementary duct design
- Familiarize students with refrigerants; vapor compression refrigeration and multi-stage vapor compression systems
- Understand the components of vapor compression systems and other types of cooling systems.

COURSE OUTCOMES (COs)	
CO1	Understand physical and mathematical aspects of refrigeration and air- Conditioning systemsandtoHVAC technology, engineering, research, systems, system designs, energyimpacts, and overall goals
CO2	Apply theoretical and mathematical principles to simple, complex vapor Compression

	and vapor absorption refrigeration systems
CO3	Understand conventional and alternate refrigerants and their impact on environmentand Develop understanding of the principles and practice of thermal comfort
CO4	Review heat transfer and solar energy engineering and develop techniques for the analysis of building envelope loads
CO5	Design air-conditioning systemsand Develop generalized psychometrics' of moist air an apply to HVAC processes

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	E
2	CO1			M		M
	CO2	M	M		H	
	CO3	H		H		M
	CO4	H	M	H	M	H
	CO5	H	L	M	M	M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 VAPOUR COMPRESSION SYSTEM **9**

Actual vapor compression system – Multipressurevapour compression system – Environment Friendly refrigerants – cascade system.

UNIT-2 VAPOUR ABSORPTION SYSTEM **9**

Absorption refrigeration system – Three fluid absorption system – comparison of absorption with Compression system - Analysis of multistage systems

UNIT-3 PSYCHROMETRY & COOLING LOAD CALCULATIONS **9**

Advanced psychrometric calculations - Cooling load calculations – Determination of U factor – Short method calculation

UNIT-4 CRYOGENICS **9**

Low temperature refrigeration – Joule Thompson coefficient – liquefaction of air – hydrogen – Helium – Applications of cryogenics.

UNIT-5 DUCTS **9**

Room air distribution – Friction losses in ducts - Duct design, Air filters clean rooms – Air Curtain

Text book:
Arora, c.P., *Refrigeration and Air Conditioning, 2nd* ed., Tata McGraw-Hill, 2004.

References:

1. Stoeker, W.P. and Jones, J.W., *Refrigeration and Air Conditioning, 2nd* ed., Tata McGraw-Hill , 1982.
2. Manohar Prasad, *Refrigeration and Air Conditioning,* New Age International, 1996.
3. Gosney, W.B., *Principles of Refrigeration,* Cambridge Uni. Press, 1982.

Total no of periods: 45

Course Code MME 304	Course Name: ENVIRONMENTAL POLLUTION ANI CONTROL	L	T	P	C
	Total Contact Hours: 45	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:
The course is intended to

- Learn the principles of air and water pollution, effect of these pollutants on the environment and the methods available to control them.
- Familiar with technical and scientific methods for treating, controlling or safely disposing of air and water emissions, which could pose a threat to the environment

COURSE OUTCOMES (COs)

CO1	Design of mechanical systems and interdisciplinary engineering applications and busir solutions using suitable optimization technique
CO2	Apply numerical or iterative techniques in power systems for optimal power flow solutions
CO3	Optimize the parameters in control systems for desired steady state or transient response
CO4	Optimize the cost function in deciding economic factors of power systems
CO5	Design of electrical systems optimally using suitable techniques like un variety method, steepest descent method etc

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	M			-	L
	CO2		M	H	-	L
	CO3	M			M	M
	CO4			H	M	M
	CO5	H	M	M	L	-

3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 AIR POLLUTION **9**

Air pollution – Classification and properties of Air pollutants – Sampling and analysis of air pollutants –Control of air pollution.

UNIT-2 AIR POLLUTION MODEL & CONTROL **9**

Dispersion of air pollutants - Gaussian plume model- Control of gaseous pollutants - Volatile organic compounds - Control of gaseous emission - Air pollution laws and standards.

UNIT-3 WATER POLLUTION **9**

Water pollution - Sampling and analysis of waste treatment – Advanced waste water treatments by physical, chemical, biological and thermal methods - Effluent quality standards.

UNIT-4 WASTE MANAGEMENT **9**

Solid waste management - Classification and their sources - Health hazards - Handling of toxic and radioactive wastes - Incineration and verification.

UNIT-5 APPLICATION OF POLLUTION CONTROL METHODS **9**

Pollution control in process industries namely Cement, Paper, Petroleum and petrochemical, Fertilizers and distilleries, thermal power plants and automobiles.

References:

1. Manster, G.M., *Introduction to Engineering and Science, 2nd* ed., Pearson Publishers, 2004.
2. Rao, E.S., *Environmental Pollution Control Engineering*, Wiley Eastern Ltd., 1991.
3. Mahajan, S.P., *Pollution Control in Process Industries*, Tata McGraw-Hill, 1985.
4. Crawford, M., *Air Pollution Control Theory*, TMH, 1976.

Total no of periods: 45

ELECTIVES

Course Code	Course Name: ANALYSIS AND DESIGN OF PRESSURE VESSELS	L	T	P	C

MMD 203	Total Contact Hours: 45	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:
To understand the different types of stresses and their effects in pressure ves
To understand the piping layout and the stresses acting on it.

COURSE OUTCOMES (COs)

CO1	Will understand the different types of stresses and their effects in pressure vessel
CO2	Will understand the piping layout and the stresses acting on it
CO3	To understand the piping layout and the stresses acting on it.
CO4	To understand the different types of stresses and their effects in pressure vessel
CO5	To understand the different types of piping layout

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	L				H
	CO2		H			
	√					
	CO4					
	CO5					
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 DESIGN CONDITION FOR PRESSURE VESSELS 9
Establishment of design conditions – Fracture Mechanics – Heads, Basic shell thickness - Reinforcement of openings – Special components like flange, tube plate, supports.

UNIT-2 THICK CYLINDERS 9
Cylindrical shells – Thick cylinders- Lame's solution - Theories of breakdown of elastic action – Unrestrained solution – Lateral loading – General loading. Axisymmetric loading - Membrane solutions - Edge bending solutions - Flexibility matrix.

UNIT-3GENERAL ANALYSIS 9
Application of general analysis – Flat closure plates –conical heads and reducers – hemispherical andtorispherical, ellipsoidal heads.

UNIT-4 FAILURE MODES 9

Development of cracks - Fracture mechanics - Corrosion - Selection of working stress for ductile and brittle materials.

UNIT-5 FEA IN PRESSURE VESSELS 9

Finite element analysis for high pressure and high temperature components.

Text book:

1. Bickell, M.B. and Ruiz, c., *Pressure Vessel Design and Analysis,* MacMillan, London, 1967.

References:

1. Den Hartog, J.P., *Advanced Strength of Materials,* McGraw-Hill, 1949.
2. Timoshenko, S., *Strength of Materials,* Van Nostrand, 1986.

Total no of periods: 45

<table>
<tr><td rowspan="4">Course Code
MME E2</td><td>Course Name: ENERGY CONSERVATION, MANAGEMENT, AND AUDIT</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Total Contact Hours:</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Prerequisite:</td></tr>
<tr><td colspan="5">Course Designed by : Department of Mechanical Engineering</td></tr>
<tr><td colspan="6">OBJECTIVES:
Demonstrate the importance and role of energy management in the functional areas Manufacturing Industry, Process Industry,. Commerce and Government
Enable the students to understand the basic energy conversion and management principles and to identify sources of energy loss and target savings
Enable students in carrying out budgeting and risk analysis
Analyze the performance of the wind turbine</td></tr>
</table>

COURSE OUTCOMES (COs)

CO1	Explain the fundamentals of energy management and its influence on environment and to Develop the concepts of energy management which is essential in the functional areas like Manufacturing Industry, Process Industry,. Commerce and Government
CO2	Understand the basic energy conversion and management principles and to identify sources of energy loss and target savings andDescribe methods of energy production for improved utilization
CO3	Carry out budgeting and risk analysisandApply the principles of thermal engineering and energy management to improve the performance of thermal systems
CO4	Analyze the performance of the wind turbineAssess energy projects on the basis of economic and financial criteria
CO5	Apply the principles of thermal engineering and energy management to improve the performance of thermal systems

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	M			-	L

	CO2		M	H	-	L
	CO3	M			M	M
	CO4			H	M	M
	CO5	H	M	M	L	-
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 BASICS OF ENERGY **9**

Energy Scenario - Basics of Energy and its various forms - Energy Management and -Audit - Material and Energy Balance -Energy Action Planning-Financial Management -Project Management -Energy Monitoring and Targeting -Global Environmental Concerns

UNIT-2 COMBUSTION OF FUELS & BOILERS **9**

Energy Efficiency in Thermal Utilities – Fuels and Combustion-Boilers-Steam System-Furnaces –Insulation and Refractory –FBC Boilers –Cogeneration –Waste heat recovery

UNIT-3 ELECTRICAL SYSTEMS **9**

Energy Efficiency in Electrical Utilities-Electrical Systems-Electric Motors-Compressed Air System-HVAC and Refrigeration System-Fans and Blowers-Pumps and Pumping System-Cooling Tower-Lighting System-Diesel Generating System-Energy Efficient Technologies in Electrical Systems

UNIT-4 ENERGY AUXILITY **9**

Energy Performance Assessment for Equipment and Utility systems -Boilers-Furnaces-Cogeneration, Turbines (Gas, Steam)- Heat Exchangers-Electric Motors and Variable Speed

UNIT-5 RENEWABLE ENERGY SOURCES & WASTE MINIMIZATION **9**

Drives-Fans and Blowers-Water Pumps-Compressors

HVAC Systems-Lighting Systems-Performing Financial Analysis-Applications of Non-Conventional and Renewable Energy Sources-Waste Minimization and Resource Conservation

Text book:

Guide book for National Certification Examination for Energy Managers and Energy Auditors, Bureau of energy efficiencies, 2005.

Total no of periods: 45

Course Code MME E5	Course Name: **BOILER AUXILIARIES AND PERFORMANCE EVALUATION**	L	T	P	C
	Total Contact Hours:	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				
OBJECTIVES					
COURSE OUTCOMES (COs)					
CO1					
CO2					
CO3					
CO4					
CO5					

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	E
2	CO1					
	CO2					
	CO3					
	CO4					
	CO5					
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 BOILER TYPES & EFFICIENCY 9

Boiler types - Efficiency calculation - Balance diagram – Boiler start up calculations –Boiler turbine matching – Power Plant balance diagram

UNIT-2 FUEL &ASH HANDLING EQUIPMENTS 9

Fuel and Ash handling Equipment – Crushers and Mills - Drum internals - Specification and selection.

UNIT-3 PUMPS & FANS 9

Feed pumps – Different types, Specifications, Operation and maintenance aspects - Fans, blowers– Applications – Performance requirements, Selection, Operation and maintenance.

UNIT-4 DUST CLEANING EQUIPMENTS 9

Dust cleaning equipment – Selection criteria – Design, operation and maintenance of electro static precipitators, Bag filters.

UNIT-5 SOOT BLOWERS 9

Soot blowers – Various types and their constructional features – Specifications – Selection – Operation and Maintenance.

Text book:

Shields, C.D., *Boilers, Types Characteristics and Functions*, McGraw-Hill, 1961.

References:

1. *Modern Power Station Practice*, CEGB London, Pergamon Press, 1991.
2. Eck, B., *Fans*, Pergamon Press, 1973.

Total no of periods: 45

Course Code MTE E6	**Course Name: HEAT TRANSFER EQUIPMENT DESIGN**	**L**	**T**	**P**	**C**
	Total Contact Hours:	3	0	0	3
	Prerequisite:				
	Course Designed by :				

OBJECTIVES:

The course is intended to

- Design and analyses the heat exchangers parallel flow, counter flow, multipass and, cross flow heat exchanger
- Design and analyze the Shell and tube heat exchanger
- Enable to carry out the performance of heat exchanger with the extended surfaces.
- Design and analyses the cooling towers.

COURSE OUTCOMES (COs)

CO1	Design and analyze the parallel flow, counter flow, multi-pass and, cross flow heat exchangers
CO2	Develop the Shell and tube heat exchanger
CO3	Optimize the performance of heat exchanger
CO4	Design and analyze the cooling towers
CO5	Apply the concepts of radiation heat transfer for enclosure analysis

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	E
2	CO1	H	M	-	M	H
	CO2	H	M	-	M	M
	CO3	H	M	-	M	M

	CO4	H	L	-	M	H
	CO5	H	M	-	L	M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 INTRODUCTION **9**

Classification of heat transfer equipment – Design of shell and tube heat exchanger – Finned Surface heat exchanger –Heat exchangers for special services – Fired heaters

UNIT-2 HEAT EXCHANGER & HEAT PIPES **9**

Plate and spiral plate heat exchanger – plate heat exchanger for Dairy industry – Heat Pipes

UNIT-3 DESIGN OF AUXILLARY SYSTEMS **9**

Thermal design of heat exchange equipments such as Air pre-heaters , Economizer – Super heater and condensers.

UNIT-4 HEAT EXCHANGER SELECTION **9**

Selection of compact heat exchangers.

UNIT-5 COOLING TOWERS DESIGN AND ANALYSIS **9**

Analysis and design of cooling towers.

Text book:

Ganapathy, v., *Applied Heat Transfer,* Pennwell Books, 1982.

References:

1. Kays, W.M. and London, A.L., *Compact Heat Exchangers,* McGraw-Hill, 1998.
2. Dunn, P. and Reay, D.A., *Heat Pipes,* Pergamon, 1994.
3. Kakac, S. and Liu, H., *Heat Exchangers,* CRC Press

Total no of periods: 45

Course	**Course Name: INSTALLATION, TESTING, AND**	**L**	**T**	**P**	**C**

Code MME E7	OPERATION OF BOILERS				
	Total Contact Hours:	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:
To impart knowledge regarding insulation of boilers, ducts and dampers, insulation of boilers, boiler commissioning testing inspection and cleaning of boilers.

COURSE OUTCOMES (COs)

CO1	Can install boilers with all safety measures
CO2	Can provide insulation of boilers
CO3	Can commission a boiler
CO4	Can estimate life of very old boilers
CO5	Can do performance test on boilers.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	A	b	c	D	e
2	CO1	H	M	-	M	H
	CO2	H	M	-	M	M
	CO3	H	M	-	M	M
	CO4	H	L	-	M	H
	CO5	H	M	-	L	M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 INSTALLATION OF BOILERS **9**
Installation of boilers – Supporting structures, Sequence of Erection, HSFC Bolts – Drum lifting alignment - Provision for expansion of water walls

UNIT-2 DUCTS & DAMPERS **9**
Erection of Ducts - ESP - APH - and fans- Alignment. Erection of ducts and dampers – Cold pull.

UNIT-3 INSULATION OF BOILERS **9**
Lining and Insulation – Material characteristics and selection - Procedure for mounting Gaskets for erection of boilers.

UNIT-4 BOILER COMMISSIONING **9**

Boiler commissioning activities – Drying out –Boiling out – Chemical cleaning initial operation – Abnormal operations – precautions –shutting down

UNIT-5 TESTING,INSPECTION& CLEANING **9**

Codes for Testing, Inspection and cleaning – Boiler pressure parts – Life estimation for very old boilers – Thermal performance test and capacity restoration.

References:

1. *Erection of Boilers and Auxiliary Equipment*, Manuals Prepared by B.H.E.L., Tiruchirappalli, 1990.

Total no of periods: 45

Course Code MME E9	Course Name: NON DESTRUCTIVE TESTING AND FAILURE ANALYSIS	L	T	P	C
	Total Contact Hours:	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:

1. To understand the principles behind various NDT techniques
2. To study about NDT equipments and accessories
3. To learn working procedures of various NDT techniques

COURSE OUTCOMES (COs)	
CO1	Demonstrate good grounding in the area of NDT
CO2	To select proper NDT Method for his application
CO3	Understand the utilization of test and measurement appropriate to the area of his study/problem
CO4	Comparison and selection of different NDT methods
CO5	design and material Improvements derived from case studies

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	E
2	CO1	M	M	-	M	H
	CO2	M	M	-	M	M
	CO3	M	M	-	M	M
	CO4	M	L	-	M	H
	CO5	M	M	-	L	M

3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1
NDT V/s destructive testing – advantages and limitations – different types of NDT

UNIT-2 **9**
Detailed discussion of LPT, MPT and radiography

UNIT-3 **9**
Eddy current and ultrasonic techniques

UNIT-4 **9**
Comparison and selection of different NDT methods – statistical significance – reliability aspects – Need for multiple NDT procedures in critical components – concept of NDE

UNIT-5 **9**
Concept of failure analysis – methodology, approaches and tools – design and material Improvements derived from case studies – fracture mechanics approach

References:
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.

Total no of periods: 45

Course Code MME E10	**Course Name: FRONTIER MATERIALS**	**L**	**T**	**P**	**C**
	Total Contact Hours:	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				
OBJECTIVES: • To impart knowledge regarding various types of smart materials and steels					
COURSE OUTCOMES (COs)					
CO1	Understand the mechanical behavior such as tensile, fatigue and creep of ductile				

	and brittle materials
CO2	Analyze Failure of various components
CO3	Understand Materials characterization techniques
CO4	Analyze different types of steels
CO5	Analyze different types of smart material like shape memory alloys

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	M	M	-	M	H
	CO2	M	M	-	M	M
	CO3	M	M	-	M	M
	CO4	M	L	-	M	H
	CO5	M	M	-	L	M
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th , 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT-1 INTRODUCTION 9

Trends and developments in materials – historical perspective – challenging applications

UNIT-2 TOP DOWN – BOTTOM DOWN APPROACHES 9

Need for microstructurally engineering materials – top down and bottom up approaches in Assemblage of materials / particles

UNIT-3METALLIC GLASSES 9

Detailed discussion on specific material systems – metallic glasses – processing conditions – bulkmetallic glasses

UNIT-4 STEELS & ALLOYS OF STEELS 9

Stainless steel and special steels – low-density high strength alloys – super alloys – cryogenic Materials

UNIT-5 SMG, FGM9

Shape memory alloys – FGM’s – biomaterials – nano materials

Text book:

Leslie. V. C., *Physical Metallurgy of steels*, McGraw Hill, 1982.

References:

Polmear. I. J., *Light Alloys, Metallurgy of Light Metals*.3rd edition, Arnold 1995.

Total no of periods: 45

Course Code MME E11	**Course Name: COMBUSTION ENGINEERING**	***L***	***T***	***P***	***C***
	Total Contact Hours:	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:
To impart knowledge regarding nature and mechanism of combustion phenomena and relate combustion with engine performance

COURSE OUTCOMES (COs)

CO1	Apply thermodynamic analysis to IC engines and describe combustion phenomena. In spark ignition and compression ignition engines
CO2	Describe the working of major systems used in conventional and modern engines
CO3	Summarize the methods used to improve engine performance and estimate Performance parameters
CO4	Describe engine emission control techniques and implement viable alternate fuels
CO5	Describe Fluidization fundamentals, combustion in bubbling bed, atmospheric fluidized bed combustion systems.

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	e
2	CO1	M	-	H	-	-
	CO2	H	H	H	H	H
	CO3	L	H	H	H	L
	CO4	-	-	H	H	H
	CO5					
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th , 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I CHEMICAL REACTIONS

Fuels and combustion, Theoretical and actual combustion processes, Enthalpy of formation and enthalpy of combustion, First law analysis of Reacting systems, Adiabatic flame temperature, Entropy change of reacting systems, Second law analysis of reacting systems, problems

UNIT II COMBUSTION OF GASEOUS AND VAPORIZED FUELS 9

Review of types of fuels, Types of flames, Energy balance and furnace efficiency, Burner type, Emissions from gas-fired furnaces, Emissions control, Chamber design, Detonation

UNIT III COMBUSTION OF LIQUID FUELS 9

Spray combustion in furnace, spray formation and droplet behaviour, Gas turbine operating parameters, combustor design, ignition delay, and detonation of liquid fuel sprays

UNIT IV COMBUSTION OF SOLID FUELS 9

Drying of solid fuels, devolatilization of solid fuels, stoker-fired boilers, Refuse and biomass fired boilers, Pulverized coal-burning systems, Pulverized coal combustion, Emission from pulverized coal, Problems

UNIT V FLUIDIZED BED COMBUSTION 9

Fluidization fundamentals, combustion in bubbling bed, atmospheric fluidized bed combustion systems, are circulating fluidized beds, pressurized fluidized bed combustion, problems.

References:

1. *Gary.L.Borman, Combustion Engineering-McGraw Hill international Edition,1998*
2. *Roger.A.Strehlow-Combustion fundamentals- McGraw Hill international Edition,1989*
3. *Yunus.A.Cengel-Thermodynamics-International edition,2006*

TOTAL NO. OF PERIODS: 45

Course Code MME E13	**Course Name: NEW AND RENEWABLE SOURCES OF ENERGY**	**L**	**T**	**P**	**C**
	Total Contact Hours:	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:

The course is intended to

- Provide a fundamental treatment of fluid flows controlled by viscous or turbulent stress gradients andthe subsequent heat transfer between fluids and solid surfaces.
- Provide analytical solutions to the momentum and energy conservation equations for both laminar and turbulent flows will be considered.
- Provide solid foundation for the engineering practitioner engaged in single phase convective thermal transport.
- Provide solid foundation for further studies in multiphase convective transport.

COURSE OUTCOMES (COs)

CO1	Identify the renewable energy sources and their utilization
CO2	Understand the basic concepts of the solar radiation and analyze the solar

	Thermal systems for their utilization
CO3	Understand the principle of working of solar cells and their modern Manufacturing
CO4	Understand the concepts of the ocean thermal energy conversion systems and their applications
CO5	Outline the methods of energy storage and identify the appropriate methods of Energy stor for specific applications

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	c	d	E
2	CO1	M	M	M	M	M
	CO2	M	H	M	M	H
	CO3	M	H	M	M	L
	CO4	M	H	L	M	L
	CO5	M	H	M	M	L
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
				√		
4	Approval	37th , 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I WIND ENERGY 9

Introduction-Location of Wind Generators-Types of Windmills-Induction and Synchronous Systems

UNIT II SOLAR ENERGY 9

Principle of Conversion of Solar Radiation into Heat, Types of Solar Thermal Collectors- Flat Plate and Concentrating Collectors (Parabolic, Trough, Minor Strip, Fresnel Lens and Compound Parabolic Concentrator), Comparison of Collectors, Selective Absorber Coatings, Solar Thermal Power Plant

UNIT III SOLAR ENERGY STORAGE AND APPLICATION 9

Solar energy storage systems- thermal, electrical, chemical, mechanical and electromagnetic, solar pond.Application of solar energy- solar thermoelectric conversion- solar photo voltaics, solar heating and cooling of buildings, solar distillation, solar pumping and solar cookers. System of solar cell power plant- direct grid connection through electronic control devices

UNIT IV BIO- MASS 9

Sources Of Bio-Mass Energy- Wood And Agricultural Waste- Municipal Waste- Animal Waste- Energy Conservation Systems- Biogas Generation From Animal Waste- Wood Gasification- Downdraft And Fluidized Bed Systems- Alcohol Fuels

UNIT V OTHERSOURCES 9

Wave Energy- Scope and Simple Systems for Power Generation, Tidal Power- Scope and Applications, Otec-Scope, Fundamental Principles and Operating System for Power Generation

References:

1. *David M.Eggleston and Forrest S.Stoddard,Wind Turbine Engineering Designing- Van Noustrand 1987*
2. *Rai,G.D. Non – Conventional Sources of Energy, Khanna publications, 4th edition 2004*
3. *Le Gouries.D, Wind Power Plants, Theory and Design –permagon press,1982.*
4. *F.S.seiler, Alternate Energy Vehicle Information, Wind Book Inc.,1977*
5. *Barbara Keiler, Energy Alternatives,Luscentr Books,1990*
6. *T.NejatVeziroygal, Alternative Energy Sources-III,Hemisphre Publishing co.,1989.*

TOTAL NO OF PERIODS-45

Course Code	Course Name: **NUCLEARENGINEERING**	L	T	P	C
MME E133	Total Contact Hours:	3	0	0	3
	Prerequisite:				
	Course Designed by : Department of Mechanical Engineering				

OBJECTIVES:

To gain some fundamental knowledge about nuclear physics, nuclear reactor, nuclear fuels, reactors and safe disposal of nuclear wastes.

COURSE OUTCOMES (COs)

CO1	Will understand the principal of nuclear physics
CO2	Will understand about nuclear reactions and nuclear reaction materials
CO3	Will understand the nuclear fuel cycles
CO4	Will understand the nuclear reactor
CO5	Will understand the safety and disposal

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	B	C	D	E
2	CO1	H				
	CO2		L			
	CO3			M		
	CO4				H	
	CO5					L

3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th, 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I NUCLEAR PHYSICS 9

Nuclear model of an atom-Equivalence of mass and energy-binding- radio activity-half life-neutron interactions-cross sections.

UNIT II NUCLEAR REACTIONS AND REACTION MATERIALS 9

Mechanism of nuclear fission and fusion- radio activity- chain reactions-critical mass and composition-nuclear fuel cycles and its characteristics-uranium production and purification-Zirconium, thorium, beryllium.

UNIT III REPROCESSING 9

Reprocessing: nuclear fuel cycles-spent fuel characteristics-role of solvent extraction in reprocessing-solvent extraction equipment.

UNIT IV NUCLEAR REACTOR 9

Nuclear reactors: types of fast breeding reactors-design and construction of fastbreeding reactors-heat transfer techniques in nuclear reactors- reactor shielding. Fusion reactors.

UNIT V SAFETY AND DISPOSAL 9

Safety and disposal: Nuclear plant safety-safety systems-changes and consequences of accident-criteria for safety-nuclear waste-types of waste and its disposal-radiation hazards and their prevention-weapons proliferation.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Thomas J.Cannoly, “Fundamentals of nuclear Engineering” John Wiley 1978.90

REFERENCES:

1. Collier J.G., and Hewitt G.F, “Introduction to Nuclear power”, Hemisphere publishing, New York. 1987

2. WakilM.M.El., "Power Plant Technology" – McGraw-Hill International, 1984.

<table>
<tr><td rowspan="4">Course Code
EY7202</td><td>Course Name: DESIGN AND ANALYSIS OF TURBOMACHINES</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Total Contact Hours:</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Prerequisite:</td></tr>
<tr><td colspan="5">Course Designed by : Department of Mechanical Engineering</td></tr>
<tr><td colspan="6">OBJECTIVES:
1. To understand the energy transfer process in Turbo machines and governing equations of various forms.
2. To understand the structural and functional aspects of major components of Turbo machines.
3. To design various Turbo machines for power plant and aircraft applications</td></tr>
<tr><td colspan="6">COURSE OUTCOMES (COs)</td></tr>
<tr><td>CO1</td><td colspan="5"></td></tr>
<tr><td>CO2</td><td colspan="5"></td></tr>
<tr><td>CO3</td><td colspan="5"></td></tr>
<tr><td>CO4</td><td colspan="5"></td></tr>
<tr><td>CO5</td><td colspan="5"></td></tr>
</table>

<table>
<tr><td colspan="7">Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low</td></tr>
<tr><td>1</td><td>COs/Pos</td><td>a</td><td>B</td><td>c</td><td>D</td><td>e</td></tr>
<tr><td rowspan="5">2</td><td>CO1</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Category</td><td>Professional Mathematics (PM)</td><td>Professional Core (PC)</td><td>Professional Elective (PE)</td><td>Open Elective (OE)</td><td>Project/ Term Paper Seminar/ Internship (PR)</td></tr>
<tr><td></td><td>√</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td>Approval</td><td colspan="5">37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016</td></tr>
</table>

UNIT I INTRODUCTION 12

Basics of isentropic flow – static and stagnation properties – diffuser and nozzle configurations - area ratio – mass flow rate – critical properties. Energy transfer between fluid and rotor velocity triangles fora generalized turbo machines - velocity diagrams. Euler's equation for turbo machines and its differentForms. Degree of reaction in turbo-machines – various efficiencies – isentropic, mechanical, thermal, Overall and polytrophic

UNIT II CENTRIFUGAL AND AXIAL FLOW COMPRESSORS 9

Centrifugal compressor - configuration and working – slip factor - work input factor – ideal and actual work - pressure coefficient - pressure ratio. Axial flow compressor – geometry and working – velocity diagrams – ideal and actual work – stage pressure ratio - free vortex theory – performance curves and losses

UNIT III COMBUSTION CHAMBER 6

Basics of combustion. Structure and working of combustion chamber – combustion chamber Arrangements - flame stability – fuel injection nozzles. Flame stabilization - cooling of combustion chamber

UNIT IV AXIAL AND RADIAL FLOW TURBINES 9

Elementary theory of axial flow turbines - stage parameters- multi-staging - stage loading and flow coefficients. Degree of reaction - stage temperature and pressure ratios – single and twin spool arrangements – performance.Matching of components.Blade Cooling.Radial flow turbines.

UNIT V GAS TURBINE AND JET ENGINE CYCLES 9

Gas turbine cycle analysis – simple and actual. Reheated, Regenerative and Intercooled cycles forpower plants. Working of Turbojet, Turbofan, Turboprop, Ramjet, Scarmjet and Pulsejet Engines andcycle analysis – thrust, specific impulse, specific fuel consumption, thermal and propulsive efficiencies.

TOTAL: 45 PERIODS

<table>
<tr><td rowspan="4">Course Code
TE7011</td><td>Course Name: ADVANCED THERMAL STORAGE TECHNOLOGIES L T P C</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>Total Contact Hours:</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Prerequisite:</td></tr>
<tr><td colspan="5">Course Designed by : Department of Mechanical Engineering</td></tr>
<tr><td colspan="6">OBJECTIVES:
1. To learn the various types of thermal storage systems and the storage materials
2.To develop the ability to model and analyze the sensible and latent heat storage units
3. To study the various applications of thermal storage systems</td></tr>
<tr><td colspan="6">COURSE OUTCOMES (COs)</td></tr>
<tr><td>CO1</td><td colspan="5"></td></tr>
<tr><td>CO2</td><td colspan="5"></td></tr>
<tr><td>CO3</td><td colspan="5"></td></tr>
<tr><td>CO4</td><td colspan="5"></td></tr>
<tr><td>CO5</td><td colspan="5"></td></tr>
<tr><td colspan="6">Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low</td></tr>
</table>

1	COs/Pos	a	b	c	D	e
2	CO1					
	CO2					
	CO3					
	CO4					
	CO5					

3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th& 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

UNIT I INTRODUCTION 8

Necessity of thermal storage – types-energy storage devices – comparison of energy storage Technologies - seasonal thermal energy storage - storage materials.

UNIT II SENSIBLE HEAT STORAGE SYSTEM 9

Basic concepts and modeling of heat storage units - modeling of simple water and rock bed storagesystem – use of TRNSYS – pressurized water storage system for power plant applications – packedbeds.

UNIT III REGENERATORS 10

Parallel flow and counter flow regenerators – finite conductivity model – non – linear model – transientperformance – step changes in inlet gas temperature – step changes in gas flow rate – parameterization of transient response – heat storage exchangers.

UNIT IV LATENT HEAT STORAGE SYSTEMS 9

Modeling of phase change problems – temperature based model - enthalpy model - porous mediumapproach - conduction dominated phase change – convection dominated phase change.

UNIT V APPLICATIONS 9

Specific areas of application of energy storage – food preservation – waste heat recovery – solar energy storage – green house heating – power plant applications – drying and heating for process industries.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.

REFERENCES:

1. Schmidt.F.W and Willmott.A.J, Thermal Storage and Regeneration, Hemisphere Publishing Corporation, 1981.
2. Lunardini.V.J, Heat Transfer in Cold Climates, John Wiley and Sons 1981

RESEARCH METHODOLOGY

Course Code	Course Name: RESEARCH METHODOLOGY	L	T	P	C
	Total Contact Hours:	3	0	0	3

MST070	Prerequisite:	
	Course Designed by :	

OBJECTIVES:
- To Get adequate knowledge about research concepts
- To describe mathematical modeling and simulation
- To understand experimental modeling
- To get knowledge about the interpretation of result

COURSE OUTCOMES (COs)

CO1	To describe research concepts
CO2	To Get adequate knowledge about mathematical modeling
CO3	To describe experimental modeling
CO4	To understand analysis of results
CO5	To know about report writing

Mapping of Course Outcomes with Program outcomes (POs)
(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/Pos	a	b	C	d	E
2	CO1	S	M			
	CO2	S	M			
	CO3	S	M			
	CO4	S	M			
	CO5	S	M			
3	Category	Professional Mathematics (PM)	Professional Core (PC)	Professional Elective (PE)	Open Elective (OE)	Project/ Term Paper Seminar/ Internship (PR)
			√			
4	Approval	37th , 38th & 39th Meeting of Academic Council, May 2015, Jan 2016 & April 2016				

1. RESEARCH CONCEPTS **9**

Concepts, meaning, objectives, motivation, types of research, approaches, research (Descriptive research, Conceptual, Theoretical, Applied & Experimental).

Formulation of Research Task – Literature Review, Importance & Methods, Sources, quantification of Cause Effect Relations, Discussions, Field Study, Critical Analysis of Generated Facts, Hypothetical proposals for future development and testing, selection of Research task.

2. MATHEMATICAL MODELING AND SIMULATION **9**

Concepts of modeling, Classification of Mathematical Models, Modeling with Ordinary differential Equations, Difference Equations, Partial Differential equations, Graphs, Simulation, Process of formulation of Model based on Simulation.

3 EXPERIMENTAL MODELING 9

Definition of Experimental Design, Examples, and Single factor Experiments, Guidelines for designing experiments. Process Optimization and Designed experiments, Methods for study of response surface, determining optimum combination of factors, Taguchi approach to parameter design.

4 ANALYSIS OF RESULTS 9

Parametric and Non-parametric, descriptive and Inferential data, types of data, collection of data (normal distribution, calculation of correlation coefficient), processing, analysis, error analysis, different methods, analysis of variance, significance of variance, analysis of covariance, multiple regression, testing linearity and non-linearity of model.

5 REPORT WRITING 9

Types of reports, layout of research report, interpretation of results, style manual, layout and format, style of writing, typing, references, tables, figures, conclusion, appendices.

TOTAL: 45

TEXT BOOKS

1. Wilkinson K. L, Bhandarkar P. L, „Formulation of Hypothesis‟, Himalaya Publication.
2. SchankFr.,"Theories of Engineering Experiments‟, Tata McGraw Hill Publication.

REFERENCE BOOKS

1. Douglas Montgomery, "Design of Experiments‟, Statistical Consulting Services, 1990.
2. Douglas H. W. Allan, "Statistical Quality Control: An Introduction for Management‟, Reinhold Pub Corp, 1959.
3. Cochran and Cocks, „Experimental Design‟, John Willy & Sons.
4. John W. Besr and James V. Kahn, „Research in Education‟, PHI Publication.
5. Adler and Granovky, "Optimization of Engineering Experiments‟, Meer Publication.
6. S. S. Rao, „Optimization Theory and Application‟, Wiley Eastern Ltd., New Delhi, 1996.