RKUNIVERSITY

SYLLABUS

SCHOOL OF ENGINEERING
ACADEMIC YEAR - 2019-20
DEFINATION OF ONE CREDIT:

PROGRAM: M. TECH – THERMAL SCIENCE (MECHANICAL ENGINEERING)
SEMESTER – II (Batch - 2019-21)

1. **Lecture (L):** 1 hour / week / semester,
2. **Practical (P):** 2 hour / week / semester,
3. **Tutorial (T):** 2 hour / week / semester.

TEACHING SCHEME										
Course Code	**Course Name**	**Teaching Hours**			**SSH**	**Credits**	**Audit course**	**CIE**	**PSEE**	**Remarks if any**
		Theory	**Tutorial**	**Practical**						
TH216	Advanced Refrigeration and Air-Conditioning Systems	3	0	2	2	4	N	Y	Y	
TH217	Acoustics and Noise Control	3	0	0	3	3	N	Y	N	
TH218	Computational Fluid Dynamics	3	0	2	3	4	N	Y	Y	
TH219	Advanced Thermal Power Plant Engineering	2	0	2	2	3	N	Y	Y	
TH220	Design of Heat Exchange Equipments	3	0	2	2	4	N	Y	Y	
TH9YY	Elective – II	4	0	2	3	5	N	Y	Y	Any One Offered Dept. Elect. - I
PG201	Software Lab - II	0	0	2	3	1	N	Y	Y	
	TOTAL	**18**	**0**	**12**	**18**	**24**				
		Total Teaching Hours 30								

N- No
Y – Yes

CIE – Continuous internal evaluation
PSEE – Practical semester end examination including ITD, Dissertation, Industrial project, Industrial training etc.
SSH - Self-study hours

HOD **Director**

SCHOOL OF ENGINEERING
ACADEMIC YEAR - 2019-20
DEFINATION OF ONE CREDIT:

PROGRAM: M. TECH – THERMAL SCIENCE (MECHANICAL ENGINEERING)
SEMESTER – II (Batch - 2019-21)

1. **Lecture (L):** 1 hour / week / semester,
2. **Practical (P):** 2 hour / week / semester,
3. **Tutorial (T):** 2 hour / week / semester.

Elective – II										
Course Code	**Course Name**	**Teaching Hours**			**SSH**	**Credits**	**Audit course**	**CIE**	**PSEE**	**Remarks if any**
		Theory	**Tutorial**	**Practical**						
TH914	ANALYSIS AND DESIGN OF THERMAL TURBO MACHINES	4	0	2	3	5	N	Y	Y	Any One Offered Elect. - II
TH916	EXERGY ANALYSIS OF THERMAL SYSTEMS	4	0	2	3	5	N	Y	Y	
TH917	ENERGY AUDIT AND MANAGEMENT	4	0	2	3	5	N	Y	Y	

N- No
Y – Yes

CIE – Continuous internal evaluation
PSEE – Practical semester end examination including ITD, Dissertation, Industrial project, Industrial training etc.
SSH - Self-study hours

HOD **Director**

RKUNIVERSITY

SYLLABUS

Course Title	ADVANCED REFRIGERATION AND AIR-CONDITIONING SYSTEMS
Course Code	TH216
Course Credit	Lecture : 03
	Practical : 01
	Tutorial : 00
	Total : 04

Course Learning Outcomes

After Successful completion of the above course; students will be able to:

- **Indicate** the refrigeration process on P-h and T-S diagrams.
- **Use** diagrams of thermodynamic processes and properties to solve refrigeration design problems.
- **Distinguish** performance of different refrigerants according to application.
- **Compare** VCRS and VARS.
- **Estimate** heating and cooling load for different applications.
- **Design** a seminar hall by using load calculation.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Compound Vapor Compression Refrigeration System:** Compound compression with flash and liquid intercooler. Compound compression with multiple expansion valve and parallel operations; sectionalizing and booster operations; cascade refrigeration system. Analysis of the compound vapor compression refrigeration system with use of p-H charts and solution of problems. Balancing of vapor compression refrigeration system components. Advantages of compound vapor compression refrigeration systems. Dual pressure vapor compression refrigeration system and its analysis.	10
2	**Vapor Absorption Refrigeration System:** Theory and working fundamental of VARS; comparison of VARS against VCRS; advantages of VARS refrigeration system. Basic VARS system and functioning of different components; meaning of use of two fluids.	8

	Types of VARS system. (H20-NH3 & Li-Br). Analysis of water ammonia absorption system based on enthalpy concentration charts and equilibrium charts; heat balance and C.O.P.Two stage vapor absorption refrigeration system.	
3	**Miscellaneous Refrigeration Systems and Introduction to Heat Pumps:** Air cycle refrigeration system; Steam jet refrigeration system; Different heat pump cycles.	**3**
	Total	**21**
	SECTION-II	
4	**Psychrometry:** Psychometric charts: ASHRAE and CARRIER charts; their differences; Application of corrections of different charts. Applied Psychrometry Combinations of different processes and their representation on psychrometric charts. psychrometric calculations for cooling and dehumidification High latent heat load; dehumidified air quantities based on total and effective room loads. GSHF and ESHF; effect of fan and duct heat gain or dehumidified air quantity; effective surface temperature; effect of bypass factor on GSHF; analysis for using all outside air; psychrometric of partial load control	**8**
5	**Load Calculation:** Heat gain calculations. Choices of supply conditions; Solar heat gain: Terminology calculation different solar angels; relation between different angles; calculation of the intensity of direct; diffused and ground radiation solar air temperature. Empirical methods to evaluate heat transfer through walls; and roofs; TETD and its determination by calculation and tables; Heat gain through glass; Solar heat gain factor; use of equations and tables; shading of glass; solar chart and its use. shading of glass; solar chart and its use; shading devices and its selection; load due to other sources; stack effect. Different methods of calculating cooling load as per ASHRE-some brief idea (other than TETD methods)	**5**
6	**Duct Design:** Duct Design: Types of ducts; duct construction; factors affecting duct construction. Friction charts and other correction factors; losses; design velocity and its selection. Duct heat gain or loss; duct insulation; duct layouts; duct sizing methods; equal friction static regains, and T-method design simple idea. Noise and their isolation; duct materials and their accessories.	**8**
	Total	**21**

Instructional Method and Pedagogy:

- At the beginning of course; the course delivery pattern; prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector; blackboard; OHP etc.
- Attendance is compulsory in lectures and tutorial.
- Minimum two internal exams will be conducted and average of two will be considered as a part of overall evaluation.

- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regularly.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.

Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

Reference Books:

1. Pita Edward G; “Air conditioning principles and systems”; Prentice-Hall of India Private Limited; New Delhi.
2. Stoecker W. F & Jones J. W; “Refrigeration and air-conditioning”; McGraw Hill International; New York
3. C.P.Arora; “Refrigeration and air-conditioning”; Tata McGraw-Hill Publishing Company Limited; New Delhi.
4. P.S. Desai; “Modern refrigeration and air conditioning for engineers”; principles; practice and application; Khanna Publishers.
5. Thipse S.S; “Refrigeration and air conditioning”; Jaico Publishing House; Mumbai
6. Rajput R.K “Refrigeration and air conditioning”; S. K. Kataria& Sons; Delhi
7. Ballaney P.L; “Refrigeration and air conditioning”; Khanna Book Publishing Co. (P) Ltd. Delhi.

Additional Resources:

- http://nptel.ac.in/courses/Webcourse
- contents/IIT%20Kharagpur/Ref%20and%20Air%20Cond/New_index1.html
- http://nptel.ac.in/courses/112105128/
- http://www.newagepublishers.com/samplechapter/001246.pdf

Course Title	ACOUSTICS AND NOISE CONTROL
Course Code	TH217
Course Credit	Lecture : 03
	Practical : 00
	Tutorial : 00
	Total : 03

Course Learning Outcomes

After Successful completion of the above course; students will be able to:

- **Review** the fundamentals of vibration, acoustics and its measurement.
- **Evaluate** and **analyses** vibration and acoustics of various components.
- **Suggest** probable solutions for mitigation of vibration and noise.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Acoustics and it's Measurement** Speed of Sound, Wavelength, Frequency, and Wave Number, Acoustic Pressure and Particle Velocity, Acoustic Intensity and Acoustic Energy Density, Spherical Waves, Factor and Directivity Index, Levels and the Decibel, Combination of Sound Sources, Octave Bands, Weighted Sound Levels, Sound Level Meters, Intensity Level Meters, Octave Band Filters, Acoustic Analyzers, Dosimeter, Measurement of Sound Power, Noise Measurement Procedures.	7
2	**Vibration Instrumentation** Vibration Exciters, Types of Shakers, Force Rating, Power Rating, Stroke Rating, Example, Hydraulic Shakers, Inertial Shakers, Electromagnetic Shakers, Control System, Components of a Shaker Controller, Signal-Generating Equipment, Performance Specification Parameters for Performance Specification, Motion Sensors and Transducers, Force & Torque Sensors, Component Interconnection.	7
3	**Noise Sources** Fan Noise, Electric Motor Noise, Pump Noise, Gas Compressor Noise, Transformer Noise, Cooling Tower Noise, Noise from Gas Vents, Appliance and Equipment Noise, Valve Noise, Air Distribution System Noise, Traffic Noise, Train Noise, Principles of Noise Control.	4

4	**Acoustic Criteria** Human Ear, Hearing Loss, Industrial Noise Criteria, Speech Interference Level, Criteria for Interior Spaces, Community Reaction to Environmental Noise, The Day-Night Level, HUD Criteria, Aircraft Noise Criteria.	**3**
	Total	**21**
	SECTION-II	
5	**Vibration Signal Analysis** Frequency & Spectrums, Signal Types, Fourier Analysis, Analysis of Random Signals, Ergodic Random Signals, Correlation and Spectral Density, Frequency Response Using Digital Fourier Transform, Leakage (Truncation Error), Coherence, Parseval's Theorem, Window Functions, Spectral Approach to Process Monitoring, Cepstrum, Bandwidth, Transmission Level of a Band-pass Filter, Effective Noise Bandwidth, Half-Power (or 3 dB) Bandwidth, Fourier Analysis Bandwidth, Resolution in Digital Fourier Results, Overlapped Processing, Speed Spectral Map, Time Spectral Map, Order Tracking.	**5**
6	**Modal Analysis** Degrees of Freedom and Independent Coordinates, System Representation, Modal Vibrations, Orthogonality of Natural Modes, Static Modes and Rigid Body Modes, Non-Symmetric Modal Formulation, Transformed Symmetric Modal Formulation, Forced Vibration, Damped Systems, State-Space Approach.	**5**
7	**Design of acoustics systems** Design Requirements, Lumped Parameter Analysis, The Helmholtz Resonator, Side Branch Mufflers, Expansion Chamber Mufflers, Dissipative Mufflers, Evaluation of the Attenuation Coefficient, Commercial Silencers, Plenum Chambers	**5**
8	**Vibration Isolation and Case Studies for Noise Control** Mechanical Impedance and Mobility, Transmissibility, Rotating Unbalance, Displacement Excitation, Dynamic Vibration Isolator, Vibration Isolation Materials, Effects of Vibration on Humans. Introduction, Folding Carton Packing Station Noise, Metal Cut-Off Saw Noise, Paper Machine Wet End, Air Scrap Handling Duct Noise, Air-Operated Hoist Motor, Blanking Press Noise, Noise in a Small Meeting Room	**6**
	Total	**21**

Instructional Method and Pedagogy:

- Lectures will be conducted with the aid of multi-media projector, blackboard, OHP etc.
- Assignments based on course content will be given to the research scholar at the

end of each unit/topic and will be evaluated at regular interval.

- Surprise tests/Quizzes/Seminar will be conducted.

Reference books:

1. Randall F. Barron, "Industrial Noise Control and Acoustics", Marcel Dekker, Inc.
2. Clarence W. de Silva. "Vibration Fundamentals and Practice", Boca Raton: CRC Press LLC, 2000.
3. J.M. Krodkiewski, "Mechanical Vibration", The University of Melbourne.
4. V. P. Singh, "Mechanical Vibrations", Dhanpat Rai & Co.
5. Meirovitch Leonard, "Elements of Vibration Analysis", McGraw Hill Education (India) Private Limited.
6. William J Palm, "Mechanical Vibration", John Wiley & Sons, Inc.
7. Singiresu S Rao, "Mechanical Vibration", Pearson India.

Additional Resources

- https://nptel.ac.in/courses/112106225/
- https://nptel.ac.in/courses/112104212/
- https://nptel.ac.in/courses/112104194/
- https://nptel.ac.in/courses/112104227/

Course Title	COMPUTATIONAL FLUID DYNAMICS
Course Code	TH218
Course Credit	Lecture : 03
	Practical : 01
	Tutorial : 00
	Total : 04

Course Learning Outcomes

At the end of the course the students will be able to

- **Understand** about SIMPLE and MAC algorithm for computational methods and apply the same in various turbulent models.
- **Develop** a detailed understanding of the analytical approaches and numerical procedures currently used in modern CFD software.
- **Understand** Physical meaning of the governing equations of continuity, momentum and energy thereby developing the platform to solve these partial differential equations with the use of analytical methods or the specialized software like ANSYS, FLUENT etc.
- **Understand** and learn the basic Discretization techniques involved in computational modeling and be able to apply them to simple benchmark problems and understand the concept of validation.
- **Understand** and analyze the various simplified models of turbulent fluid flow using specially developed algorithms.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Introduction &Basic Concepts:** Introduction of CFD, Types of fluids and basic equations of flow, Conservation of mass, Newton's Second law of Motion, Governing equations of fluid flow, Navier-Stokes equations, Boundary layer equations, Expanded form of N-S equations, Conservation of energy principle, Special form of N-S equations, Classification of second order partial differential equations, Initial and boundary conditions, Governing equations in generalized coordinates. Review of essentials of fluid dynamics.	**10**
2	**Finite Difference Methods.** Differential Equations & Discretization: Elementary Finite Difference	**11**

	Equations, Basic aspects of Finite Difference Equations, Errors and Stability Analysis, Discretization, Application to heat conduction and convection, Problems on 1-D and 2-D steady state and unsteady state conduction, Problem on Advection phenomenon, Incorporation of Advection scheme.	
	Total	**21**
	SECTION-II	
3	**Finite Element Method**. Introduction to Finite Element Philosophy, Basics of finite element method, Stiffness matrix, isoperimetric elements, formulation of finite elements for 1-D & 2-D flow& heat transfer problems.	**6**
4	**Finite Volume Method** Introduction to Finite Volume Philosophy, Integral approach, Discretization &higher order schemes, Application to Complex Geometry.	**7**
5	**SIMPLE and MAC Algorithm** Introduction to solutions of viscous incompressible flows using MAC & Simple algorithm.	**4**
6	**Incompressible Fluid Flows and Turbulence Models** Governing equations of viscous incompressible flows by stream function, vorticity formulation, two dimensional incompressible viscous flows, Turbulence, Effect of Turbulence and time averaged Navier stokes Equation, Algebric Models – One equation model, k-e models, algebraic stress model.	**4**
	Total	**21**

Instructional Method and Pedagogy:

- At the beginning of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
- Attendance is compulsory in lectures and laboratory.
- Minimum two internal exams will be conducted and average of two will be considered as a part of overall evaluation.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regularly.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
- Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

Reference Books:

1. Anderson D.A., Tannehilj. c. Pletcher R.H., “Computational fluid mechanics & heat transfer” Hemisphere publishing corporation, Newyork, U.S.A 2004.
2. Anker S.V., “Numerical heat transfer & flow” Hemisphere corporation, 2001
3. H.K.verstag & W.Malalsekra,” An introduction to computational fluid dynamics Longman-2000
4. Carnahan B, “Applied numerical method” John Wiley & Sons-2001.
5. Patankar, “Numerical heat transfer & Fluid Flow”, Mc. Graw Hill.,2002
6. Murlidhar K., Sunder rajan T., “Computational Fluid Mechanics and Heat Transfer” Narosa Publishing House.
7. Bose,T.K.,"Numerical Fluid Dynamics" Narosa Publishing House, 1997.
8. Date A. W., “Introduction to Computational Fluid Dynamics”, Cambrige Uni. Press, 2005

Additional Resources:

- nptel.ac.in/courses/112105045/
- www.**cfd**-online.com/
- www.ansys.com/Products/Simulation+Technology/***Fluid***+***Dynamics***
- www3.nd.edu/~gtryggva/***CFD****-Intro.pdf*
- www.inderscience.com/p***cfd***

Course Title	ADVANCED THERMAL POWER PLANT ENGINEERING
Course Code	TH219
Course Credit	Lecture : 02
	Practical : 01
	Tutorial : 00
	Total : 03

Course Learning Outcomes

At the end of the course the students will be able to

- **Analyze** steam power plant cycle and select appropriate process parameters for Rankine cycle.
- **Evaluate** methods for efficiency improvements in Rankine cycle.
- **Understand** the non-applicability of the Carnot cycle for vapor power cycle and compare Rankine cycle with Carnot cycle.
- **Analyze** Brayton cycle and evaluate the options for improvements in the efficiency of the Brayton cycle.
- **Understand** working of Nuclear and Diesel electric power plants.
- **Perform** the economic analysis of the power generation plants.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Steam Power Plant:** Recent trends in Steam Power Plants, design of combustion chambers, Fluidized bed combustion chambers, burners and selection criteria, combustion calculations, Design and selection for economizers, air-preheater, superheater, desuperheaters, and reheaters. Performance testing and maintenance, Design of Advanced boiler and steam system, heat balance sheet, co-generation and Combined cycle, boiler efficiency, thermodynamics and power plant cycle analysis, Power plant layout and selection, Arrangement of units. Advancement in high Pressure boilers and miniature boilers.	7
2	**Nuclear Power Plant:** Modern nuclear power plants and their arrangement, Types of nuclear furnaces and moderator, heat exchangers, turbines for nuclear power plants, Nuclear waste disposal, Gas disposal system.	4
3	**Diesel Electric Power Plant:** Advances in diesel electric power plant, types of engines used, analysis of thermodynamic cycles, Supercharging of diesel engine, performance and analysis of diesel power plant, present development in diesel power plant.	3
	Total	14

SECTION-II		
4	**Economical Analysis of Power Plant:** Cost electric energy, selection of type of generation and generating equipment, Performance and operating characteristic, Load division and tariff method.	3
5	**Fluctuating Loads on Power Plants:** Introduction, load curves, Different terms and definitions, Effect of variable load on power plant design and operation, Method to meet variable loads.	2
6	**Peak Load Plants:** Requirements, Pump storage power plants, Economical justification of pump storage plant, their advantages and disadvantages, Compressed air storage plants, their advantages and limitation.	2
7	**Energy Conservation and Management:** Distribution of energy consumption, load sharing, need of energy conservation, Methods of energy conservation, energy management techniques.	2
8	**Gas Turbine Power Plant:** Classification and comparison of different types of gas turbine power plants, Thermodynamic cycles, Analysis of closed cycle and open cycle gas turbine plants, Methods of improving the thermal efficiency and power output of gas turbine plants, Different components of gas turbine plants and different arrangements of gas turbine components, Types of combustion chambers used, fuels and fuel handling equipment, Governing of gas turbines. Combined steam and gas turbine plants. Recent developments of gas turbine power plants.	5
	Total	14

Instructional Method and Pedagogy:

- At the beginning of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
- Attendance is compulsory in lectures and laboratory.
- Minimum two internal exams will be conducted and average of two will be considered as a part of overall evaluation.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regularly.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
- Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

Reference Books:

- Black and Vetach, “Power Plant Engineering”, Chapman and Hall, International
- Thomson Publishing Co., 2001.
- El, Wakil,” Power Plant Technology”, McGraw-Hill, 2003.
- Gebhartt, G. F.,” Steam Power Plant Engineering”, John Wiley & Sons, 2002.
- Kearton,” Steam Turbine Theory and Practice”, ELBS, 2001.
- Burger R., “Cooling Tower Technology”, Chemical Publishing Company
- Shields, C. D., “Boilers”, McGraw Hill, New York, 2001
- Babcock-Wilcox manual “Steam”
- Vandagriff, R.L “Practical guide to boiler systems”, Marcel Dekker, 2000
- Oliver, K.G “Industrial boiler management, an operations guide, Industrial Press,
- NewYork. 2002

Additional Resources:

- www.rwe.com
- www.energymanagertraining.com
- www.wartsila.com
- www.oegindia.com
- www.aerb.gov.in
- www.vitkovicepower.cz

Course Title	DESIGN OF HEAT EXCHANGE EQUIPMENTS
Course Code	TH220
Course Credit	Lecture : 03
	Practical : 01
	Tutorial : 00
	Total : 04

Course Learning Outcomes

At the end of the course the students will be able to

- **Understand** and solve the real-life industrial problems for heat exchanger design and optimization.
- **Analyze** and get thorough insights of heat exchanger design which will be helpful for students to pursue their dissertation work.
- **Develop** on experience in MATLAB for design and optimization problems related to heat exchanger design.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Review of The Basic Fundamentals:** Heat transfer mechanism, heat transfer between fluids, heat transfer principles, Basics of conduction and convection correlation.	3
2	**Introduction to Heat Exchanger and Classification:** Detailed classification of heat exchangers, Detailed explanation of working of various types of heat exchanger and the functioning of the heat exchanger components.	6
3	**Basic Design Methodology of Heat Exchangers:** Logarithmic mean temperature difference method, Number of transfer units (NTU)-Effectives method, Analysis of heat exchanger using the above methods, Comparison of both the design methods.	8
4	**Design of Double Pipe Heat Exchangers.**	2
5	**Plate Type Heat Exchanger Design.**	2
	Total	**21**

SECTION-II		
6	**Design of Shell and Tube Heat Exchangers:** Shell side and tube side design considerations, Kerns method, Bell-delware method, j factors Solution of design using MATLAB software in the above methods, Conventional design methods.	**9**
7	**Compact Heat Exchanger Design:** J factors, design method	**3**
8	**Condenser Design:** Condenser classification and design method for surface condenser	**3**
9	**Evaporators:** Classification and design methods.	**2**
10	**Miscellaneous in Heat Exchanger Design:** TEMA standards for heat exchanger design, Introduction to ASME codes and applications, Heat exchanger design considerations and methodology, Fouling of heat exchanger and its prevention.	**4**
	Total	**21**

Instructional Method and Pedagogy:

- At the beginning of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
- Attendance is compulsory in lectures and laboratory.
- Minimum two internal exams will be conducted and average of two will be considered as a part of overall evaluation.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regularly.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
- Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

Reference Books:

1. Saunders, E.A.D., “Heat Exchangers – Selection Design and Construction”, Longmann Scientific and Technical, N.Y., 2001.
2. Kays, V.A. and London, A.L., “Compact Heat Exchangers”, McGraw Hill, 2002.
3. Holger Martin, “Heat Exchangers” Hemisphere Publ. Corp., Washington, 2001.
4. Kuppan, T., “Heat Exchanger Design Handbook”, Macel Dekker, Inc., N.Y., 2000
5. Seikan Ishigai, “Steam Power Engineering, Thermal and Hydraulic Design Principles”,Cambridge Univ. Press, 2001.
6. R.K.Shah, “fundamentals of heat exchanger design”.
7. sadickakac “heat exchangers”.

Additional Resources:

1. http://nptel.ac.in/courses/103103027/pdf/mod1.pdf

2. http://www.thomasnet.com/articles/process-equipment/heat-exchanger-design

Course Title	SOFTWARE LAB - II
Course Code	PG201
Course Credit	Theory :00
	Practical :01
	Tutorial :00
	Credits :01

Course Learning Outcomes:

After Successful completion of the course, students will be able to:

- **Generate** virtual model of different engineering equipment.
- **Solve** problems from different engineering domain using ANSYSAPDL.
- **Perform** analysis of different mechanical components and systems to find different parameters effecting component and system design and optimization

Detailed Syllabus

Sr. No.	Name of chapter & details	Hours Allotted
1	**INTRODUCTION TO FEA AND ANSYS:** General Working of FEA-Nodes, Elements, and Element Shapes-Effective Utilization of FEA-FEA Software-Advantages and Limitations of FEA Software-Types of Analysis-Structural Analysis - Thermal Analysis - Fluid Flow Analysis - Coupled Field Analysis-Important Terms and Definitions-Strength (Resistance to Deformation) -Load -Stress - Strain -Elastic Limit- Ultimate Strength Factor of Safety - Lateral Strain and Poisson's Ratio- Bulk Modulus - Creep Engineering Materials-ANSYS Metaphysics Utility Menu Window-Utility Menu - Main Menu - Graphics Area - Standard Toolbar ANSYS Command Prompt - Command Window Icon- Raise Hidden Icon Reset Picking - Contact Manager - ANSYS Toolbar Model Control Toolbar User Prompt Information -Current Settings	2
2	**SOLID MODELING:** Creating Geometric Entities -Creating Lines - Creating Arcs- Creating B-Spines - Creating Fillets between Intersecting - Lines Creating Areas -Advanced Solid Modeling-Creating Volumes Extruding Entities Extending the Line-Modifying the Solid Model-Scale – Move- Copy – Reflect-Deleting Solid Model Entities-Importing Solid Models-Importing the IGES File	4
3	**FINITE ELEMENT MODELING:** Element Attributes-Element Types-Real Constants -Material Properties -Multiple Attributes-Assigning Multiple Attributes before Meshing-Assigning Default Attributes before Meshing-Modifying Attributes after Meshing -Verifying Assigned Attributes - Element	6

	Attributes Table-Mesh Generation -Mesh Density - Meshing the Solid Model	
4	**SOLUTION AND POSTPROCESSOR:** Solution-Defining the New Analysis Type - Restarting the Analysis - Setting Solution Controls - Setting Analysis Options - Solving the Analysis Problem-Post processing the Result-(General Postprocessor)- (Time-history Postprocessor) - Result Coordinate System (RSYS) - Displaying the Deformed Shape of the Model - Displaying the Minimum and Maximum Stresses - Listing Reaction Forces - Listing Stress Values at each Node - Query Picking - Path Operations - Load Case Combinations	**6**
5	**GENERAL POST PROCESSOR:** Result Viewing- Graph Generation - Report Generation- Animation	**4**
6	Solution to Different Case Studies Related to Design & Thermal Problems	**6**
	Total hours	**28**

Instructional method and Pedagogy:

- Entire syllabus is to be covered in Practical hours and it is not part of theory exam.
- Assignments / Exercises based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular intervals.
  For Each Lab session first, the training session would be held and then hands on session would be executed.

Reference Books:

1) Ansys Workbench 14.0 for Engineers and Designers: A Tutorial Approach by Sham Tickoo, Dreamtech Press

Additional Resources

- http://mae.uta.edu/~lawrence/ansys/ansys_examples.htm
- http://www.mece.ualberta.ca/tutorials/ansys/AT/Joints/Joints.html
- https://confluence.cornell.edu/display/SIMULATION/FLUENT+-+Bifurcating+Artery

Course Title	ANALYSIS AND DESIGN OF THERMAL TURBO MACHINES (ELECTIVE –II)
Course Code	TH914
Course Credit	Lecture : 04
	Practical : 01
	Tutorial : 00
	Total : 05

Course Learning Outcomes

After Successful completion of the above course, students will be able to:

- **Understand** the various systems, principles, operations and applications of different types of turbo machinery components.
- **Analyze** energy transfer between fluid and rotor-classification of fluid machinery, dimensionless parameters, specific speed applications, stage velocity triangles, work and efficiency.
- **Evaluate** Stage velocity diagrams, enthalpy-entropy diagrams, stage losses and efficiency, work done simple stage design problems and performance characteristics of different types of compressor and turbines.
- **Understand** and to choose the optimum parameters of the different components of the turbo machines based on the analysis of the velocity triangles and performance characteristic curves.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Design of Compressor:** Design of compressors, Centrifugal compressor, Inlet section, Impeller passages. Effect of impeller blade shape on performance, Impeller channel, Vane less and vaned diffusers, Effect of Mach number, Design procedure.	9
2	**Axial Flow Compressor:** Axial flow compressor, stage characteristics, Blading efficiency, Design parameters, Blade loading, Lift coefficient and solidity, Three-dimensional flow considerations, Radial equilibrium design approach, Actuator disc theory approach, Design procedure and calculations.	10

3	**Design of Turbulent Flow:** Design of turbine flow passages, Introduction, Isentropic velocity ratio, Energy distribution in turbines, Effect of carryover velocity on energy distribution.	**9**
	Total	**28**
	SECTION-II	
4	**Impulse Turbine Design:** Impulse turbine flow passages, Blade pitch and width, Blade height, Blade entrance and exit angles, Geometry of impulse blade profiles, Losses in impulse blade passages, Design procedure for single stage and multistage impulse turbines.	**9**
5	**Reaction Turbine Design:** Reaction turbine flow passages, Reaction blade profiles, Blade angles, Gauging and pitch, Blade width and height, Losses in reaction blade passages, Degree of reaction, design procedure for impulse, reaction turbines, Calculations for axial thrust, Turbines for optimum capacity.	**9**
6	**Flow Passage Design:** Flow passage with radial equilibrium, the free vortex turbine, Turbine with constant specific mass flow, Turbines with constant nozzle angle, comparison of radial equilibrium design, off design performance using radial equilibrium theory, Actuator disc theory, Single parameter analysis, Stream line curvature methods.	**10**
	Total	**28**

Instructional Method and Pedagogy:

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Reference Books:

1. Lee J.E., “Steam & Gas Turbine”, McGraw Hill city, 2001.
2. Shlyakhin P., “Steam Turbines, Theory & Design”, Peace Publications, Moscow, 2000.
3. Frank P. Beleier, “Fan Hand Book Selection”, Application and Design”, Wiley, 2003.
4. Saravanamootoo, H.I.H., & Rogers, G.F.C., “Gas Turbine Theory”, Pearson Pub. Company,
Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi 2001.
5. B. K. Venkanna, “Fundamentals of Turbo Machinery”, PHI Learning Private Limited, New Delhi.
6. V. Ganesan, “Gas Turbines”, Tata Mcgrow Hill Publishing Co. Ltd., New Delhi.

Additional Resources:

- http://nptel.ac.in/downloads/101101058/
- https://books.google.co.in/books?id=uHjmtloxOSEC&printsec=frontcover&dq=turbo+machines&hl=en&sa=X&ei=ZBg7Va3sIIKVuATwxoD4BA&ved=0CDcQ6AEwBA#v=onepage&q=turbo machines&f=false
- http://27.54.180.75/Opac/audiovideo.asp
- http://ebooks.asmedigitalcollection.asme.org/solr/searchresults.aspx?q=turbo%20machines&allBooks=1&f_ContentType=eBooks&SearchSourceType=3

Course Title	EXERGY ANALYSIS OF THERMAL SYSTEMS (ELECTIVE –II)
Course Code	TH916
Course Credit	Lecture : 04
	Practical : 01
	Tutorial : 00
	Total : 05

Course Learning Outcomes

After Successful completion of the above course, students will be able to:

- **Aspects** of exergetic approach for the evaluation and performance optimization of the thermal process plants and systems.
- **Combine** the economic aspect with exergy for optimum performance of various thermal systems.
- **Differentiate** between the exergetic and energy approach for the design and evaluation of process plants.
- **Familiarize** the students with the concepts of Exergy and its importance in thermal systems.
- To make them understand about the design aspects of various equipment considering exergy and energy approach.
- **Differentiate** about the concept of energy and exergy.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Basic concepts of energy analysis of thermal systems:**	**08**
2	**Basic exergy concepts:** • Classification of forms of exergy • Concepts of exergy • Exergy concepts for a control region, physical exergy • Chemical exergy • Exergy concepts for closed system analysis.	**10**

3	**Elements of plant analysis:** • Control mass analysis, • Control region analysis • Criteria of performance • Pictorial representation of exergy balance • Exergy based property diagram.	**10**
	Total	**28**
	SECTION-II	
4	**Exergy analysis of processes:** • Expansions process, • Compression processes, • Heat transfer process, • Mixing & separation Process, • Chemical process including combustion.	**14**
5	**Energy analysis of thermal systems:** • Gas turbine plant, • Thermal power plant • Cogeneration plant • Captive power plant • Combined cycle power plant • Refrigeration plant • Chemical plant Linde air liquification plant, Heat exchanger.	**14**
	Total	**28**

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Reference Books:

1. Kotas J.J., “The Exergy Methods of Thermal Plant Analysis”, 2nd Ed., Krieger Publ. Corp. U.S.A., 2000.
2. Larry, C.W., Schmidt, P.S., and Schmidt, P.S. and David, R.B., “Industrial Energy Management and Utilization”, Hemisphere Pub. Corp., Washington, 2001.
3. Seikan, Ishigai, “Steam Power Engineering, Thermal and Hydraulic Design Principles”, Cambridge Univ., Press, 2000.
4. Turner, W.C., (Ed.), “Energy Management Handbook”, John Wiley & Sons, N.Y., 2002.
5. Dryden, I.G.C., “The Efficient use of Energy”, Butterworths, London, 2000.

Course Title	ENERGY AUDIT AND MANAGEMENT (ELECTIVE –II)
Course Code	TH917
Course Credit	Lecture : 04
	Practical : 01
	Tutorial : 00
	Total : 05

Course Learning Outcomes

After Successful completion of the above course, students will be able to:

- **Describe** effective use of energy to maximize profits (minimize costs) and enhance competitive positions.
- **Recognize** strategy of adjusting management and optimizing energy, using systems and procedures so as to reduce energy requirements per unit of output while holding constant or reducing total costs of producing the output from these systems.
- **Illustrate** how to optimize energy and its utilization, throughout the industrial arena.
- **Analyze** balance the total energy inputs with its use and serves to identify all the energy streams in a facility.
- **Explain** more about the ways energy and fuel are used in any industry and help in identifying the areas where waste can occur and where scope for improvement exists.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Energy Audit Methodology and recent trends.** • General Philosophy and need of Energy Audit and Management. • Definition and Objective of Energy Management, General Principles of Energy Management, • Energy Management Skills, Energy Management Strategy. Economics of implementation of energy optimization projects, it's constraints, barriers and limitations, • Report-writing, preparations and presentations of energy audit reports, Post monitoring of energy conservation projects, MIS, Case-studies / Report studies of Energy Audits. • Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations. Case studies of implemented energy cost optimization projects in electrical utilities as well as thermal utilities. Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy.	15

2	**Electrical Distribution and Utilization** • Electrical Systems, Transformers loss reductions, parallel operations, T & D losses, P.F. improvements, Demand Side management (DSM), Load Management, Harmonics & its improvements, Energy efficient motors and Soft starters, Automatic power factor • Controllers, Variable speed drivers, Electronic Lighting ballasts for Lighting, LED Lighting, Trends and Approaches. Study of 4 to 6 cases of Electrical Energy audit and management (Power factor improvement, Electric motors, Fans and blowers, Cooling Towers, Industrial/Commercial Lighting system, etc.)	**13**
	Total	**28**
	SECTION-II	
3	**Thermal Systems** • Boilers- performance evaluation, Loss analysis, Water treatment and its impact on boiler losses, integration of different systems in boiler operation. Advances in boiler technologies, FBC and PFBC boilers • Heat recovery Boilers- it's limitations and constraints. Furnaces- Types and classifications, applications, economics and quality aspects, heat distributions, draft controls, waste heat recovering options • Furnaces refractory- types and sections. Thermic Fluid heaters need and applications, Heat recovery and its limitations. Insulators- Hot and Cold applications, Economic thickness of insulation, Heat saving and application criteria. Steam Utilization- Properties, steam distribution and losses, steam trapping, Condensate, Flash steam recovery.	**14**
4	**System Audit of Mechanical Utilities** • Pumps, types and application, unit's assessment, improvement option, parallel and series operating pump performance. Energy Saving in Pumps & Pumping Systems. • Bloomers (Blowers) types & application, its performance assessment, series & parallel operation applications & advantages. Energy Saving in Blowers Compressors, types & applications, specific power consumption, compressed air system, & economic of system changes. • Energy Saving in Compressors & Compressed Air Systems Cooling towers, its types and performance assessment & limitations, water loss in cooling tower. • Energy Saving in Cooling Towers. Study of 4 to 6 cases of Energy Audit & Management in Industries (Boilers, Steam System, Furnaces, Insulation and Refractories, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery etc.) Study of Energy Audit reports for various Industries and Organizations.	**14**
	Total	**28**

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Reference Books:

1. W.R. Murphy, G.Mckay “Energy Management” Butterworths.
2. C.B. Smith “Energy Management Principles” Pergamon Press
3. I.G.C. Dryden “Efficient Use of Energy” Butterworth Scientific.
4. D.A. Reay “Industrial Energy Conservation” Pergammon Press
5. W.C. Turner “Energy Management Handbook” John Wiley and Sons, A Wiley Inter science publication)
6. L.C. Witte, P.S. Schmidt, D.R. Brown “Industrial Energy Management and Utilization” Hemisphere Publication, Washington, 1988
7. Energy Audit and Management volume-I IECC Press
8. Energy Efficiency in Electrical systems volume-II IECC Press

Additional Resources:

- www.rwe.com
- www.energymanagertraining.com
- www.wartsila.com
- www.oegindia.com
- www.aerb.gov.in
  www.vitkovicepower.cz