# SHRI VENKATESHWARA UNIVERSITY

**Syllabus**

**M. TECH**
**Thermal Engineering**
**II Semester**

**(w.e.f. 2019-20)**

**SCHOOL OF ENGINEERING & TECHNOLOGY**

**M. TECH**
**Thermal Engineering**
**SEMESTER-II**

| S.N0 | Subject Codes | Subject | Periods | | | Evaluation Scheme | | | | End Semester | | Total | Credit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CT | TA | Total | PS | TE | PE | Total | Credit |
| 1 | MTE-201 | Advanced Heat Transfer | 3 | 1 | 0 | 20 | 10 | 30 | | 70 | | 100 | 4 |
| 2 | MTE-202 | Steam Engineering | 3 | 1 | 0 | 20 | 10 | 30 | | 70 | | 100 | 4 |
| 3 | MTE-032 | Design of Heat Exchangers | 3 | 1 | 0 | 20 | 10 | 30 | | 70 | | 100 | 4 |
| 4 | MTE-042 | Modeling of IC Engines | 3 | 1 | 0 | 20 | 10 | 30 | | 70 | | 50 | 4 |
| 5 | MTE-211 | Thermal Engineering Lab - III | 0 | 0 | 4 | | | | 25 | | 25 | 50 | 2 |
| 6 | MTE - 212 | Thermal Engineering Lab- IV | 0 | 0 | 4 | | | | 25 | | 25 | 50 | 2 |
| 7 | MTE-221 | Mini-Project | 0 | 0 | 4 | | | | 50 | | 50 | 100 | 2 |
| 8 | AUD-102 | Disaster Management | 2 | 0 | 0 | | | | | | | | 0 |
| | | **Total** | | | | | | | | | | **550** | **22** |

# MTE-201 Advanced Heat Transfer

**Course Outcomes:**

At the end of the course:

**1.** The students are expected to understand the subject of Heat Transfer in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research

**Syllabus Contents:** **L T P**

3 -1 -0

**Unit 1**

Conduction- one and two dimensional, Fins, conduction with heat source, unsteady state heat transfer,

**Unit 2**

Natural and forced convection, integral equation, analysis and analogies,Transpiration cooling, ablation heat transfer, boiling, condensation and two phase flow mass transfer, cooling, fluidized bed combustion,

**Unit 3**

Heat pipes, Radiation, shape factor, analogy, shields,

**Unit 4**

Radiation of gases & vapours.

**References:**


1. J.P. Holman, "Heat Transfer", McGraw Hill Book Company, New York, 1990.
2. Incropera and Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, NewYork, 2000.
3. Frank Kreith, "Principles of Heat Transfer", Harper and Row Publishers, New York, 1973.
4. Donald Q. Kern "Process Heat Transfer", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1975.
5. Gupta and Prakash, "Engineering Heat Transfer", New Chand and Bros, Roorkee (U.P.) India, 1996.
6. R.C. Sachdeva "Fundamentals of Engineering Heat and Mass Transfer", Wiley Eastern Ltd., India,

# MTE-202 Steam Engineering

**Course Outcomes:**

At the end of the course:

1. Students will have the ability to explain working of different boilers and significance of mountings and accessories.
2. Students will have the ability to use techniques, skills, and modern engineering tools necessary for boiler performance assessment.
3. Students will have a theoretical and practical background in thermal systems, and will have a good understanding of energy conservation fundamentals. Students will have the ability to analyze thermal systems for energy conservation.
4. Students will have the ability to design a steam piping system, its components for a process and also design economical and effective insulation.
5. Students will have the ability to analyze a thermal system for sources of waste heat design a systems for waste heat recovery.

Students will have the ability to design and develop controls and instrumentation for effective monitoring of the process.

**Syllabus Contents:** **L T P**
3-1 -0

**Unit 1 Introduction** Fundamentals of steam generation, Quality of steam, Use of steam table, Mollier Chart Boilers ,Types, Mountings and Accessories, Combustion in boilers, Determination of adiabatic flame temperature, quantity of flue gases, Feed Water and its quality, Blow down; IBR, Boiler standards

**Unit 2 Piping & Insulation** Water Line, Steam line design and insulation; Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory- types, selection and application of refractory, Heat loss.

**Unit 3 Steam Systems** Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipments / Systems.

**Boiler Performance Assessment** Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.

**Unit 4 Energy Conservation and Waste Minimization** Energy conservation options in Boiler; waste minimization, methodology; economical viability of waste minimization

**Unit 5 Instrumentation & Control** Process instrumentation; control and monitoring. Flow pressure and temperature measuring and controlling instruments, its selection

**References:**

1. T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication
2. Domkundwar; A Course in Power Plant Engineering; Dhanapat Rai and Sons
3. Yunus A. Cengel and Boles, “Engineering Thermodynamics “,Tata McGraw-Hill Publishing Co. Ltd
4. Book II - Energy Efficiency in Thermal Utilities; Bureau of Energy Efficiency
5. Book IV - Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency
6. Edited by J. B. Kitto & S C Stultz; Steam: Its Generation and Use; The Babcock and Wilcox Company
7. P. Chatopadhyay; Boiler Operation Engineering: Questions and Answes; Tata McGrawHill Education Pvt Ltd, N Delhi

## MTE-021 Refrigeration and Cryogenics

**Course Outcomes:**

At the end of the course, students will demonstrate the ability:

1. To learn the basics of refrigeration and cryogenics and its application area.
2. To design the refrigeration systems for domestic and industrial applications like cold storages

To learn about ODP, GWP and related environment issues

**Syllabus Contents:** **L T P**

3 - -

**Unit 1**

Vapour compression refrigeration, actual cycle, second law efficiency, Multistage compression with inter-cooling, Multi-evaporator systems, Cascade systems,

**Unit 2**

Performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor, Design, selection of evaporators, condensers, control systems, motor selection,

**Unit 3**

Refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations, Refrigeration applications, food preservation, transport,

**Unit 4**

Introduction to Vapor absorption refrigeration, single effect and double effect systems,

**Unit 5**

Gas liquefaction systems - Linde-Hampson, Linde dual pressure, Claude cycle.

References:


1. R.J.Dossat, “Principles of Refrigeration”, Pearson Education Asia, 2001.
2. C.P.Arora, “Refrigeration and Air-conditioning”, Tata McGraw-Hill, 2000.
3. Stoecker & Jones, “Refrigeration and Air-conditioning”, McGraw Hill Book Company, New York, 1982.
4. Jordan & Priester, “Refrigeration and Air-conditioning”.
5. A.R.Trott, “Refrigeration and Air-conditioning”, Butterworths, 2000.

6. J.L.Threlkeld, “Thermal Environmental Engineering”, Prentice Hall, 1970.
7. Bailey, “Advanced Cryogenics”, Plenum Press, London, 1971.
8. W.F.Stoecker, “Industrial Refrigeration Handbook”, McGraw-Hill, 1998.
9. John A.Corinchock, “Technician’s Guide to Refrigeration systems”, McGrawHill.
10. P.C.Koelet, “Industrial Refrigeration: Principles, Design and Applications”, Macmillan, 1992.
11. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration.
12. Graham Walker, “Miniature Refrigerators for Cryogenic Sensors and Cold Electronics”, Clarendon Press, 1989

## MTE-022 Design of Heat Exchangers

**Course Outcomes:**

At the end of the course:

1. Students will demonstrate a basic understanding of several types of heat exchangers that will include shell-and-tube, double pipe, plate-and-frame, finned tube, and plate- fin heat exchangers, Heat pipes.
2. Students will design and analyses of shell-and-tube double pipe, compact, plate heat exchangers.
3. Students will demonstrate the performance degradation of heat exchangers subject to fouling.

**Syllabus Contents:** **L T P**
3 - -

**Unit 1**

**Heat Exchangers** – Classification according to transfer process, number of fluids, surface compactness, and construction features. Tubular heat exchanger, plate type heat exchangers, extended surface heat exchangers, heat pipe, Regenerators. Classification according to flow arrangement: counter flow, parallel flow, cross flow exchanger. Heat exchanger design methodology, assumption for heat transfer analysis, problem formulation, e-NTU method, *P*-NTU method, Mean temperature difference method, fouling of heat exchanger, effects of fouling, categories of fouling, fundamental processes of fouling.

**Unit 2**

**Double Pipe Heat Exchangers**: Thermal and Hydraulic design of inner tube, Thermal and hydraulic analysis of Annulus, Total pressure drop

**Unit 3**

**Compact Heat Exchangers**: Thermal and Hydraulic design of compact heat exchanger

**Unit 4**

**Shell and Tube heat exchangers** – Tinker’s, kern’s, and Bell Delaware’s methods, for thermal and hydraulic design of Shell and Tube heat exchangers

**Unit 5**

**Mechanical Design of Heat Exchangers** – design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such as tube sheet, shell, tubes, flanges and nozzles. Introduction to simulation and optimization of heat exchangers, flow induced vibrations.

**References:**


1. Ramesh K. Shah and Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design" John Wiley & sons Inc., 2003.
2. D.C. Kern, "Process Heat Transfer", McGraw Hill, 1950.
3. Sadik Kakac and Hongton Liu, "Heat Exchangers: Selection, Rating and Thermal Design" CRC Press, 1998.
4. A .P. Frass and M.N. Ozisik, "Heat Exchanger Design", McGraw Hill, 1984
5. Afgan N. and Schlinder E.V. "Heat Exchanger Design and Theory Source Book".
6. T. Kuppan, "Hand Book of Heat Exchanger Design".
7. "T.E.M.A. Standard", New York, 1999.
8. G. Walkers, "Industrial Heat Exchangers-A Basic Guide", McGraw Hill, 1982.

## MTE-023 Computational Fluid Dynamics

**Course Outcomes:**

At the end of the course:

**1.** The students are expected to understand the subject of Computational Fluid Dynamics and know how to use it as tool to solve the Heat Transfer and Fluid Mechanics related Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

**Syllabus Contents:** **L T P**
3 - -

**Unit 1**

**Introduction to CFD:** Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations.

**Unit 2**

**Governing Equations:** Review of Navier-Stokes Equation and simplified forms, Solution Methodology: FDM and FVM with special emphasis on FVM, Stability, Convergence and Accuracy.

**Finite Volume Method:** Domain discretization, types of mesh and quality of mesh, SIMPLE, pressure velocity coupling, Checkerboard pressure field and staggered grid approach

**Unit 3**

**Geometry Modeling and Grid Generation:** Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance

**Unit 4**

**Methodology of CFDHT:** Objectives and importance of CFDHT, CFDHT for Diffusion Equation, Convection Equation and Convection-Diffusion Equation

**Unit 5**

**Solution of N-S Equations for Incompressible Flows:** Semi-Explicit and Semi-Implicit Algorithms for Staggered Grid System and Non Staggered Grid System of N-S Equations for Incompressible Flows

**References:**

1. Computational Fluid Dynamics, The Basic with applications by John A. Anderson, Jr., McGraw Hill International editions, Mechanical Engineering series.
2. Numerical Methods in Fluid Flow & Heat Transfer by Dr. Suhas Patankar.
3. An Introduction to Computational Fluid Flow (Finite Volume Method), by H.K. Versteeg, W.Malalasekera, Printice Hall
4. Computational Methods for Fluid Dynamics by Ferziger and Peric, Springer Publication.
5. An Introduction to Computational Fluid Mechanics by Chuen-Yen Chow,Wiley Publication.
6. Computational Fluid Flow & Heat Transfer by Murlidhar and Sundarrajan, Narosa Publication.

## MTE-024 Modelling of IC Engine

**Course Outcomes:**

At the end of the course:

1. Students will demonstrate a basic understanding of several types of engine models that will include zero dimensional thermodynamic model, one dimensional and multi-dimensional, single zone, two zone etc models.
2. Students will develop models and simulate them for diesel engine petrol engine, gas engine**.**

Students will demonstrate the performance evaluation and emission standards for such modeled engines

**Syllabus Contents:** **L T P** 3 - -

**Unit1**

**Fundamentals:** Governing equations, Equilibrium charts of combustion chemistry, chemical reaction rates, and approaches of modeling, model building and integration methods, gas exchange through valves, engine and porting geometry, exhaust gas recirculation, valve lift curves.

**Unit 2**

**Thermodynamic Combustion Models of CI Engines:** Single zone models, premixed and diffusive combustion models, combustion heat release using wiebe function, wall heat transfer correlations, ignition delay, internal energy estimations, two zone model, application of heat release analysis.

**Unit 3**

**Fuel spray behavior:** Fuel injection, spray structure, fuel atomization, droplet turbulence interactions, droplet impingement on walls.

**Unit 4**

**Modeling of charging system:** Constant pressure and pulse turbo charging, compressor and turbine maps, charge air cooler.

**Unit 5**

**Mathematical models of SI Engines**: Simulation of Otto cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Autoignition modeling, single zone models, mass burning rate estimation, SI Engine with stratified charge. Friction in pumping, piston assembly, bearings and valve train etc. friction estimation for warm and warm up engines.

**References:**


1. Haywood, "I.C. Engines", Mc Graw Hill.
2. Ramos **J** (1989**)** Internal Combustion Engine Modeling**.** Hemisphere Publishing Company
3. C. D. Rakopoulos and E. G. Giakoumis, "Diesel Engine Transient
4. Operation Principles of Operation and Simulation Analysis", Springer, 2009.
5. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 1996.
6. P.A. Lakshminarayanan and Y. V. Aghav, " Modelling Diesel Combustion" Springer, 2010
7. Bernard Challen and Rodica Baranescu, "Diesel Engine Reference Book" Butterworth-Heinemann, 1999.


**MTE-211 Thermal Engineering Lab III**

**&MTE- 212 Lab Practice III and IV - Thermal Engineering**

**Syllabus Contents:** **L T P**
0- 0- 4

- The lab practice consists of the tutorials and experiments as decided by the course supervisors of the Program Core Courses (PCC) namely Design of Heat Exchangers and Computational Fluid Dynamics, Modelling of I C Engine.

**MTE-205 Mini project**

**Syllabus Contents:** **L T P**
0-0-4

- Students can take up small problems in the field of design engineering as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of anengineering problem etc.