# *Faculty of Engineering & Technology*

# *P.K.University*

# *Shivpuri (MP)*


## Evaluation Scheme & Syllabus for
## Department Of Mechanical Engineering

## M. Tech .-( Thermal Engg..)

## (I to IV Semester)

(Effective from session 2019-20)

# EVALUATION SCHEME

## M.Tech- Thermal Engg. (ME)

### Semester-I

| SUBJECT CODE | SUBJECT NAME | THEORY | | PRACTICAL | | TOTAL |
|---|---|---|---|---|---|---|
| | | SESS.(30) | EXT.(70) | SESS.(25) | EXT.(25) | |
| MTTH-101 | Simulation, Modeling & Analysis | 30 | 70 | 25 | 25 | 150 |
| MTTH-102 | Advanced Thermal Engineering | 30 | 70 | 25 | 25 | 150 |
| MTTH-103 | Alternative Fuels & Engines Pollution | 30 | 70 | NA | NA | 100 |
| MTTH-104 | Advanced I.C. Engines | 30 | 70 | NA | NA | 100 |
| MTTH-105 | Research Process & Methodology | 30 | 70 | NA | NA | 100 |

### Semester-II

| SUBJECT CODE | SUBJECT NAME | THEORY | | PRACTICAL | | TOTAL |
|---|---|---|---|---|---|---|
| | | SESS.(30) | EXT.(70) | SESS.(25) | EXT.(25) | |
| MTTH -201 | Advanced Heat & Mass Transfer | 30 | 70 | 25 | 25 | 150 |
| MTTH -202 | Computational Fluid Dynamics | 30 | 70 | NA | NA | 100 |
| MTTH -203 | Advanced Finite Element Analysis | 30 | 70 | NA | NA | 100 |
| MTTH -204 | Convective Heat Transfer | 30 | 70 | NA | NA | 100 |
| MTTH -205 | Adv .Power plant Engg | 30 | 70 | NA | NA | 100 |
| MTTH -206 | Seminar-1 | NA | NA | 25 | 25 | 50 |

### Semester-III

| SUBJECT CODE | SUBJECT NAME | THEORY | | PRACTICAL | | TOTAL |
|---|---|---|---|---|---|---|
| | | SESS.(30) | EXT.(70) | SESS.(25) | EXT.(25) | |
| MTTH -301 | Dissertation phase-I | NA | NA | 200 | 300 | 500 |
| MTTH -302 | Seminar-II | NA | NA | 50 | 50 | 100 |

### Semester-IV

| SUBJECT CODE | SUBJECT NAME | THEORY | | PRACTICAL | | TOTAL |
|---|---|---|---|---|---|---|
| | | SESS.(30) | EXT.(70) | SESS.(25) | EXT.(25) | |
| MTTH -401 | Dissertation phase-II | NA | NA | 300 | 300 | 600 |

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# *I Year I Semester*
## MTTE-101-Simulation, Modeling & Analysis

**UNIT I:** **L T P 3 0 2**

**Introduction:** Simulation: a tool, advantages and disadvantages of simulation, areas of application, systems and system environment, components of a system, discrete and continuous systems, discrete event system simulation. General Principles: Concepts in discrete event simulation, time advance algorithm, manual simulation using event scheduling, basis properties and operations.

**UNIT II:**

**Models In Simulation:** Terminology and concepts, statistical models: queuing systems; inventory systems; reliability and maintainability, limited data, discrete distributions: Bernoulli distribution; Bionomial distribution; Geometric distribution, continuous distribution: Uniform distribution; Exponential distribution; Gamma distribution; Normal distribution; Weibull distribution; Triangular Distribution; Lognormal distribution, poisson process,

**UNIT III:**

**Queueing Models:** Characteristics of queuing systems, the calling population, system capacity, arrival process, service mechanism, queuing notations, long run measures of performance of queuing systems, server utilization in G/G/1/∞/∞ queues, server utilization in G/G/C/∞/∞ queues, server utilization and system performance, costs in queuing problems, Larkovian models.

**UNIT IV:**

**Random Number Generation:** Properties of random numbers, Pseudo random numbers, techniques of generating random numbers, tests of random numbers. Random Variate Generation: Inverse transform technique, Direct transformation for the Normal and Lognormal distribution, Convolution Method, Acceptance rejection technique.

**UNIT V:**

**Input Modelling And Validation:** Steps in the development of model, data collection, Distribution identification, Parameter estimation, Goodness of Fit Tests,selecting input models without data, verification and validation of simulation models.

**Books:**

1. Simulation Modelling and Analysis by Law and Kelton, Mc Graw Hill.
2. Simulation Model Design& execution by Fishwich, Prentice Hall.
3. Discrete event system simulation by Banks, Carson, Nelson and Nicol.

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## MTTE-102-Advanced Thermal Engineering

**L T P 3 1 2**

**UNIT I:**

**REVIEW OF THERMODYNAMIC LAWS AND COROLLARIES:** Transient flow analysis, Second law thermodynamics, Entropy, Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Maxer's relation, Evaluation of thermodynamic properties of working substance.

**UNIT II:**

**FINITE DIFFERENCE METHODS FOR CONDUCTION:** ID & 2D steady state and simple transient heat conduction problems-implicit and explicit methods.

**Forced Convection:** Equations of fluid flow-concepts of continuity, momentum equations-derivation of energy equationmethods to determine heat transfer coefficient: Analytical methods-dimensional analysis and concept of exact solution. Approximate method-integral analysis. **Viscous Flow:** Derivation of Navier-Stoke's Equations for viscous compressible flow – Exact solutions to certain simple cases: Plain Poisoulle flow - Coutte flow with and without pressure gradient - Hagen Poisoulle flow - Blasius solution.

**UNIT III:**

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

**UNIT IV:**

**GAS DYNAMICS:** Fundamental thermodynamic concepts, isentropic conditions, Mach numbers and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas, Supersonic flow, oblique shock waves, Normal shock recoveries, detached shocks, Aero-foil theory.

**REFERENCES:**

1. Basic and Applied Thermodynamics/ P.K.Nag/ TMH
2. Element of Gas Dynamics/Yahya/TMH
3. Fluid Mechanics and Machines/Modi and Seth/Standard Book House

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## MTTE-103- Alternative Fuels & Engines Pollution

**L T P 3 0 0**

Alternative fuels, Biodiesel production & specifications, trans-esterification process, alcohol, emulsified fuels, DME, GTI,

Introduction to gaseous alternative fuels, Hydrogen, production, storage, combustive properties of hydrogen, hydrogen induction systems, Compressed natural gas, production, supply, storage, filling systems, LPG.

Pollutants due to transportation systems, Nature of pollutants and their formation, Local and global effects of pollutants, Effects of engine pollutants on human health, Photochemical smog, Emission regulations, regulated/unregulated pollutants, technologies to control engine pollution

**REFERENCES:**

1. Handbook of Alternative Fuel Technologies/Sunggyu Lee /Publisher: Taylor & Francis Inc.

2. Alternative Transportation Fuels: Utilization in Combustion Engines published / K.A. Subramanian /CRC Press.

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## MTTE-104- Advanced I.C. Engines

**UNIT I:** **L T P 3 0 0**

**INTRODUCTION:** Historical Review – Engine Types – Design and operating Parameters. Cycle Analysis: Thermo-chemistry of Fuel – Air mixtures, properties – Ideal Models of Engine cycles – Real Engine cycles - differences and Factors responsible for – Computer Modeling.

**UNIT II:**
**GAS EXCHANGE PROCESSES:** Volumetric Efficiency – Flow through ports – Supercharging and Turbo charging. Charge Motion: Mean velocity and Turbulent characteristics – Swirl, Squish – Pre-chamber Engine flows.

**UNIT III:**
**ENGINE COMBUSTION IN S.I ENGINES:** Combustion and Speed – Cyclic Variations – Ignition –Abnormal combustion Fuel factors, MPFI, SI engine testing.

**COMBUSTION IN CI ENGINES:** Essential Features – Types off Cycle. Pr. Data – Fuel Spray Behavior – Ignition Delay – Mixing Formation and control, Common rail fuel injection system.

**UNIT IV:**
**POLLUTANT FORMATION AND CONTROL:** Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, unburnt Hydrocarbon and particulate – Emissions – Measurement – Exhaust Gas Treatment, Catalytic converter, SCR, Particulate Traps, Lean, NOx, Catalysts.

**UNIT V:**
**ENGINE HEAT TRANSFER**: Importance of heat transfer, heat transfer and engine energy balance, Convective heat transfer , radiation heat transfer, Engine operating characteristics. Fuel supply systems for S.I. and C.I engines to use gaseous fuels like LPG, CNG and Hydrogen.

**UNIT VI:**
**MODERN TRENDS IN IC ENGINES:** Lean Burning and Adiabatic concepts, Rotary Engines, Modification in I.C engines to suit Bio – fuels, HCCI and GDI concepts.

**REFERENCES:**

1. I.C. Engines / V.Ganesan/TMH
2. I.C. Engines Fundamentals/Heywood/TMH
3. I.C. Engines/G.K. Pathak & DK Chevan/ Standerd Publications
4. I.C. Engines /RK Rajput/Laxmi Publications

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## MTTE105: Research Process and Methodology

**L T P 3 0 0**

**UNIT 1:**

**Introduction to Research and Problem Definition-**Meaning, Objective and importance of research, Types of research, steps involved in research, defining research problem.

**UNIT 2:**

**Research Design-**Research design, Methods of research design, research process and steps involved, Literature Survey

**UNIT 3:**

**Data Collection-**Classification of Data, Methods of Data Collection, Sampling, Sampling techniques procedure and methods, Ethical considerations in research

**UNIT 4:**

**Data Analysis and interpretation-**Data analysis, Statistical techniques and choosing an appropriate statistical technique, Hypothesis, Hypothesis testing, Data processing software (e.g. SPSS etc.), statistical inference, Interpretation of results

**UNIT 5:**

**Technical Writing and reporting of research-**Types of research report: Dissertation and Thesis, research paper, review article, short communication, conference presentation etc., Referencing and referencing styles, Research Journals, Indexing and citation of Journals, Intellectual property, Plagiarism

**Text Books:**

1. C. R. Kothari, Gaurav Garg, Research Methodology Methods and Techniques , New Age International publishers, Third Edition.
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 2nd Edition, SAGE, 2005
3. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition

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## MTTE-101-Simulation, Modeling & Analysis Lab

**LIST OF EXPERIMENTS:-**

1. Study of simulation software Like ARENA , MATLAB.
2. Simulation of translational and rotational mechanical systems
3. Simulation of Queuing systems
4. Simulation of Manufacturing System 5. Generation of Random number
6. Modeling and Analysis of Dynamic Systems
7. Simulation mass spring damper system
8. Simulation of hydraulic and pneumatic systems.
9. Simulation of Job shop with material handling and Flexible manufacturing systems 10. Simulation of Service Operations

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## MTTE-102-Advanced Thermal Engineering Lab

**LIST OF EXPERIMENTS:-**

1. Performance analysis of four strokes S.I. Engine- Determination of indicated and brake thermal efficiency, specific fuel consumption at different loads, Energy Balance.
2. Performance analysis of four strokes C.I. Engine- Determination of indicated and brake thermal efficiency, specific fuel consumption at different loads, Energy Balance.
3. Performance analysis of an alternate fuel on computerized IC Engine test rig.
4. Calculation of thermal conductivity of metal rods.
5. Experiment on Pin fin Apparatus (free and force convection heat transfer). 6. COP calculation on air conditioning test rig apparatus.
7. COP calculation on simple vapour compression refrigeration test rig.
8. Performance test and analysis of exhaust gases of an I.C. Engine.
9. Dryness fraction estimation of steam
10. Compressibility factor measurement of different real gases.

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## MTTE-201- Advanced Heat & Mass Transfer

**BRIEF INTRODUCTION TO DIFFERENT MODES OF HEAT TRANSFER:** Conduction: General heat Conduction equation-initial and boundary conditions. Transient heat conduction: Lumped system analysis-Heisler charts-semi infinite solid-use of shape factors in conduction-2D transient heat conduction-product solutions.

**FINITE DIFFERENCE METHODS FOR CONDUCTION:** ID & 2D steady state and simple transient heat conduction problems-implicit and explicit methods. Forced Convection: Equations of fluid flow-concepts of continuity, momentum equations derivation of energy equation-methods to determine heat transfer coefficient: Analytical methods-dimensional analysis and concept of exact solution. Approximate method-integral analysis.

**EXTERNAL FLOWS:** Flow over a flat plate: integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometries for laminar and turbulent flows. Internal flows: Fully developed flow: integral analysis for laminar heat transfer coefficient types of flow-constant wall temperature and constant heat flux boundary condition shydro dynamic & thermal entry lengths; use of empirical correlations.

**FREE CONVECTION:** Approximate analysis on laminar free convective heat transfer approximation-different geometries-combined free and forced convection. Boiling and condensation: Boiling curve-correlations-Nusselts theory of film condensation on a vertical plate-assumptions & correlations of film condensation for different geometries.

**RADIATION HEAT TRANSFER:** Radiant heat exchange in grey, non-grey bodies, with transmitting. Reflecting and absorbing media, specular surfaces, and gas radiation-radiation from flames.

**REFERENCES:** 1. Principals of Heat Transfer/Frank Kreith/Cengage Learning

2. Elements of Heat Transfer/E. Radha Krishna/CRC Press/2012
3. Heat Transfer/RK Rajput/S.Chand
4. Introduction to Heat Transfer/SK Som/PHI
5. Engineering Heat & Mass Transfer/Mahesh Rathore/Lakshmi Publications.

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## MTTE-202- Computational Fluid Dynamics

**UNIT I:**

**INTRODUCTION:** Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations.

**UNIT II:**

**SOLUTION METHODS:** Solution methods of elliptical equations — finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

**UNIT III:**

**HYPERBOLIC EQUATIONS:** explicit schemes and Von Neumann stability analysis, implicit schemes, multi-step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

**UNIT IV:**

**FORMULATIONS OF INCOMPRESSIBLE VISCOUS FLOWS:** Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods. Treatment of compressible flows: potential equation, Euler equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

**UNIT V:**

**FINITE VOLUME METHOD:** Finite volume method via finite difference method, formulations for two and three-dimensional problems.

**STANDARD VARIATIONAL METHODS:** Linear fluid flow problems, steady state problems, Transient problems.

**REFERENCES:**


1. Computational fluid dynamics/ T. J.C'hung/ Cambridge University press,2002.
2. Text book of fluid dynamics/ Frank Choriton/ CBS Publishers & distributors, 1985
3. Numerical heat transfer and fluid flow / Suhas V. Patankar/ Hema shava Publishers corporation & Mc Graw Hill.

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**MTTE-203-** Advanced Finite Element Analysis

**INTRODUCTION TO FEM**: basic concepts, historical back ground, applications of FEM, general description, comparison of FEM with other methods, variational approach, Glerkin's Methods. Co-ordinates, basic element shapes, interpolation function, Virtual energy principle, Rayleigh – Ritz method, properties of stiffness matrix, treatment of boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, straindisplacement relations.

**1 -D STRUCTURAL PROBLEMS:** Axial bar element – stiffness matrix, load vector, temperature effects, Quadratic shape functions and problems.

**ANALYSIS OF TRUSSES :** Plane Trusses and Space Truss elements and problems

**ANALYSIS OF BEAMS :** Hermite shape functions – stiffness matrix – Load vector – Problems. 2-D PROBLEMS: CST, LST, force terms, Stiffness matrix and load vectors, boundary conditions, Isoparametric elements – quadrilateral element, shape functions – Numerical Integration. Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements.

**3-D PROBLEMS:** Tetrahedran element – Jacobian matrix – Stiffness matrix.

**SCALAR FIELD PROBLEMS:** 1 -D Heat conduction-Slabs – fins - 2-D heat conduction problems –Introduction to Torsional problems.

**Dynamic considerations,** Dynamic equations – consistent mass matrix – Eigen Values, Eigen vector, natural frequencies – mode shapes – modal analysis.

**REFERENCES:**

1. The Finite Element Methods in Engineering / SS Rao / Pergamon.

2. Finite Element Methods: Basic Concepts and applications, Alavala, PHI

3. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu, Prentice –Hall

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## MTTE-204- Convective Heat Transfer

**INTRODUCTION TO FORCED, FREE & COMBINED CONVECTION** :– convective heat transfer coefficient – Application of dimensional analysis to convection – Physical interpretation of dimensionless numbers. Equations of Convective Heat Transfer: Continuity, Navier-Strokes equation & energy equation for steady state flows – similarity – Equations for turbulent convective heat transfer – Boundary layer equations for laminar, turbulent flows – Boundary layer integral equations.

**EXTERNAL LAMINAR FORCED CONVECTION:** Similarity solution for flow over an isothermal plate – integral equation solutions – Numerical solutions – Viscous dissipation effects on flow over a flat plate. External Turbulent Flows: Analogy solutions for boundary layer flows – Integral equation solutions – Effects of dissipation on flow over a flat plate. Internal Laminar Flows: Fully developed laminar flow in pipe, plane duct & ducts with other cross-sectional shapes

**Internal Turbulent Flows:** Analogy solutions for fully developed pipe flow –Thermally developing pipe & plane duct flow.

**NATURAL CONVECTION:** Boussineq approximation – Governing equations – Similarity – Boundary layer equations for free convective laminar flows – Numerical solution of boundary layer equations. Free Convective flows through a vertical channel across a rectangular enclosure – Horizontal enclosure – Turbulent natural convection.

**COMBINED CONVECTION:** Governing parameters & equations – laminar boundary layer flow over an isothermal vertical plate – combined convection over a horizontal plate – correlations for mixed convection – effect of boundary forces on turbulent flows – internal flows - internal mixed convective flows – Fully developed mixed convective flow in a vertical plane channel & in a horizontal duct.

**CONVECTIVE HEAT TRANSFER THROUGH POROUS MEDIA:** Area weighted velocity – Darcy flow model – energy equation – boundary layer solutions for 2-D forced convection – Fully developed duct flow – Natural convection in porous media – filled enclosures – stability of horizontal porous layers.

**REFERENCES**: 1. Introduction to Convective Heat Transfer Analysis/ Patrick H. Oosthuigen & David Naylor/McGraw Hill
2. Convective Heat & Mass Transfer /Kays & Crawford/TMH

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## MTTE-205- Advanced Power Plant Engineering

**UNIT I:**

**INTRODUCTION TO POWER PLANTS AND BOILERS;** Layout of Steam, Hydraulic, Diesel, MHD, Nuclear and Gas turbine Power Plants Combined Power cycles – comparison and selection, Load duration Curves Steam boilers and cycles – High pressure and Super Critical Boilers – Fluidized Bed Boilers.

**UNIT II:**

**STEAM POWER PLANT:** Fuel and ash handling ,Combustion Equipment for burning coal, Mechanical Stokers. Pulveriser, Electrostatic Precipitator, Draught- Different Types, Surface condenser types, cooling Towers.

**UNIT III:**

**NUCLEAR AND HYDEL POWER PLANTS :** Nuclear Energy-Fission , Fusion Reaction, Types of Reactors, Pressurized water reactor ,Boiling water reactor, Waste disposal and safety Hydel Power plant- Essential elements, Selection of turbines, governing of Turbines- Micro hydel developments.

**UNIT IV:**

**DIESEL AND GAS TURBINE POWER PLANT:** Types of diesel plants, components , Selection of Engine type, applications-Gas turbine power plant- Fuels- Gas turbine material – open and closed cycles- reheating – Regeneration and intercooling – combines cycle.

**UNIT V:**

**OTHER POWER PLANTS AND ECONOMICS OF POWER PLANTS;** Geo thermal OTEC- tidal- Pumped storage –Solar central receiver system Cost of electric Energy- Fixed and operating costs-Energy rates- Types tariffs- Economics of load sharing, comparison of various power plants.

**TEXT BOOKS:**

1. Arora S.C and Domkundwar S, "A Course in Power Plant Engineering", Dhanpat Rai, 2001.
2. Nag P.K ,"Power Plant Engineering". Third edition Tata McGraw- Hill , 2007.

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## MTTE-201- ADVANCED HEAT & MASS TRANSFER LAB

**LIST OF EXPERIMENTS:**

1. Determination of Steffen Boltzman Constant.
2. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers
3. Experiments on Boiling of Liquid and Condensation of Vapour
4. Experiment on Transient Conduction Heat Transfer
5. Determination of Thermal Conductivity of a Metal Rod.
6. Determination of Overall Heat Transfer Coefficient of a Composite wall.
7. Determination of Effectiveness on a Metallic fin.
8. Determination of Heat Transfer Coefficient in a free Convection on a vertical tube.
9. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.
10. Determination of Emissivity of a Surface.