MATS UNIVERSITY

SCHOOL OF ENGINEERING AND INFORMATION TECHNOLOGY

Department of Mechanical Engineering

Syllabus

For

(Two-Year Full-Time Degree Programme**)**

Master of Technology (M. Tech.)

in

Turbo Machinery

(2025-2027)

(Semester Based Course)

Scheme of Teaching & Examination
M. TECH 1st SEMESTER TURBO MACHINERY

S.N.	Code	Subject	Periods per week			Scheme of Marks		Total Credit
			L	T	P	ESE	IM	
1.	MTDSCBSC100	Research Methodology & IPR	3	-	-	70	30	3
2.	MTDSCME110	Finite Element Methods	3	-	-	70	30	4
3.	MTDSCME111	Experimental Techniques	3	-	-	70	30	4
4.	MTDSCME112	Advanced Fluid Dynamics	3	-	-	70	30	3
5.	MTDSCME113	Gas Turbine Cycle & Jet Propulsion	3	-	-	70	30	3
6.	MTDSCME114	Gas Turbine & Jet Propulsion Lab	-	-	2	30	20	2
7.	MTDSCME115	Fluid Dynamics Lab	-	-	2	30	20	2
		Total	**15**	**0**	**4**	**410**	**190**	**21**

L – Lecture, T – Tutorial, ESE – End Semester Examination,

P – Practical, IM – Internal Marks (Include Class Test & Teacher's Assessments)

Semester	:	1st M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Research Methodology & IPR
Total Theory Periods	:	48
Total Tutorial Periods	:	00
Code	:	MTDSCBSC100

Unit I: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit II: Effective literature studies approaches, analysis Plagiarism, Research ethics,
Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

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

Unit IV: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit V: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

REFERENCES:

1. 1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007. • Mayall, "Industrial Design", McGraw Hill, 1992.
5. Niebel, "Product Design", McGraw Hill, 1974. • Asimov, "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Semester	:	1st M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Finite Element Methods
Total Theory Periods	:	48
Total Tutorial Periods	:	00
Code	:	MTDSCME110

UNIT-I INTRODUCTION

Review of various approximate methods – Raleigh Ritz's, Galerkin and finitedifference methods-Governing equation and convergence criteria of finite element method.

UNIT-II DISCRETE ELEMENTS

Bar elements, uniform sections, mechanical and thermal loading, varying section, truss analysis. Beam element - problems for various loadings and boundary conditions - longitudinal and lateral vibration. Use of local and natural coordinates.

UNIT-III CONTINUUM ELEMENTS

Plane stress, Plane strain and axisymmetric problems, constant and linearstrain,triangular elements, stiffness matrix, axisymmetric load vector.

UNIT-IV ISOPARAMETRIC ELEMENTS

Definitions, Shape function for 4, 8 and 9 nodal quadrilateral elements, Stiffnessmatrix and consistent load vector, Gaussian integration

UNIT-V FIELD PROBLEM

Heat transfer problems, Steady state fin problems, Derivation of element matrices fortwo dimensional problems, Torsion problems.

TEXT BOOK

1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu – Introduction to FiniteElements in Engineering – Printice Hall India, Third Edition, 2003.
2. Rao. S.S., Finite Element Methods in Engineering, Butterworth and Heinemann,2001.

REFERENCES

8. Reddy J.N.–An Introduction to Finite Element Method – McGraw Hill – 2000.
9. Krishnamurthy, C.S., Finite Element Analysis, Tata McGraw Hill, 2000.
10. Bathe, K.J. and Wilson, E.L., Numerical Methods in Finite ElementsAnalysis,Prentice Hall of India, 1985.
11. Robert D Cook, David S Malkus, Michael E Plesha, 'Concepts and Applicationsof Finite Element Analysis', 4th edition, John Wiley and Sons, Inc., 2003.
12. Larry J Segerlind, 'Applied Finite Element Analysis', Second Edition, John Wileyand Sons, Inc. 1984.

Semester	:	1st M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Experimental Techniques
Total Theory Periods	:	48
Total Tutorial Periods	:	00
Code	:	MTDSCME111

UNIT-I

Basic concepts of Measurement, Statistical Analysis of Experimental Data Method of LeastSquares, Uncertainty Analysis.

UNIT-II

Response characteristics of Instruments – 1st & 2nd order instrument. Transducers, Vibration & Noise measurements

UNIT-III

Theory of strain gauges, Advance & Specific measurements –Stress & Strain Measurement by Photo Elastic Bench, Hotwire & Laser Doppler Anemometry.

UNIT-IV

Thermal & Transport property measurement, Thermo gravimetry, Gas Chromatography, Air Pollution & Nuclear radiation measurement.

UNIT-V

NDT, Radiography, Ultrasonography, Wind Tunnel Testing, Data Acquisition System.

REFERENCES:

1. Holman, J.P, "Experimental Methods for Engineers" 5th Ed. McGraw hillInternational Edition, 1989.
2. Doeblin, E.O., "Measurement System – Application and Design – McGraw HillInternational Ed., 1990.
3. Eckman, D.P. "Industrial Instrumentation", Wiley Eastern Ltd., New Delhi, 1990.
4. Hale, J. and Kocak, H., "Dynamics and Bifurcations", Springer-Verlag, N.Y. 1991.
5. Strogatz, S.H., "Nonlinear Dynamics and Chaos", Addison Wesley, Massachusetts,1995.
6. Helfrack, A.D. and Cooper, W.D., "Modern Electronic Instrumentation &Measurement Techniques", Prentice Hall of India Pvt. Ltd., New Delhi -2001.

Semester	:	1st M. Tech Course
Branch	:	TurboMachinery
Subject	:	Advance Fluid Dynamics
Total Theory Periods	:	48
Total Tutorial Periods	:	00
Code	:	MTDSCME112

UNIT-I

Cartesian Tensors, Basic Concepts: Types of fluids and basic equations of flow, basic concepts inlaminar and turbulent flows. Equations Governing Fluid Motion: Navier stokes equations,Boundary layer equations, Exact solutions of N -S equations, Flow between concentric rotating Cylinders, Parallel flow of a powder–law fluid.

UNIT-II

Potential Theory: Kelvin's theorem, source, sink, vortex and doublet, development ofcomplex potentials by super position, Singularities – plane flow past bodies – Dirchlettheorem - Conformal transformation and thin aerofoil theory.

UNIT-III

Laminar Boundary Layers: Blasius solution, Boundary Layers with non -zero pressuregradient, separation and vortex shedding.Turbulent Flow: Mechanism of turbulence, derivation of governing equations forturbulent flow, K-Ɛ model of turbulence, Universal velocity distribution law andfriction factor, Kinetic energy of the mean flow and fluctuations, Relaminarization.

UNIT-IV

Experimental Techniques: Pressure tubes, Thermal anemometers, Laser – Doppleranemometers, P-I velocimeter.

UNIT-V

Computational Fluid Dynamics: Philosophy of CFD, Governing equations, thinderivation and physical meaning, mathematical behaviour of P.D.E. and its impact onCFD, Finite difference scheme, Grid generation and transformation, Application toFEM and finite volume method for CFD Problems.

REFERENCES:

1. H. Schlichting, "Boundary layer Theory", McGraw Hill, 1987.
2. Jo. Hinze, "Turbulence", McGraw Hill, 1975.
3. P. Bradshaw, "Turbulence", Springer-Verleg, 1976.
4. Anderson D. A., Tannhill, I.C., and Pletcher, R.H., "Computational Fluid Mechanicsand Heat Transfer," Hemisphere Publ. Co., N.Y. 1984.
5. K. Murlishar and T. Sunderajan, "Computational Fluid Flow and Heat Transfer,"Narosa Pub. House, New Delhi, 1997.
6. Anderson, John, D., "Computational Fluid Dynamics," McGraw Hill, N.Y., 1995.
7. Fox, R. W. and McDonald, A. T., "Introduction to fluid Mechanics," John, Wiley &Sons, N. Y., 1985.
8. Shapiro, A.H., "The Dynamics and Thermodynamics of Compressible Fluid Flow,"The Ronald Press Company, N.Y., 1954.
9. Tennekes, H. and Lumley, J. L., "A First Course in Turbulence," M.I.T., Press,Cambridge, M.A. 1972.
10. Streeter, V.L. and Wylie, E.B., "Fluid Mechanics," McGraw Hill Int. StudentEdition, 1979.
11. Zucrow, M. "Gas Dynamics," John Wiley & Sons, 1976.

Semester	:	1st M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Gas Turbine Cycles and Jet Propulsion
Total Theory Periods	:	48
Total Tutorial Periods	:	00
Code	:	MTDSCME113

UNIT-I

Open cycle, Twin Shaft Arrangement, Multi Spool Arrangement of Gas Turbines,Closed Cycles, Aircraft Propulsion, and Environmental Issues.

UNIT-II

Ideal Cycles, Combustion and Combustion Chambers, Component Losses,performancecalculations Comparison with practical Cycles.

UNIT-III

Criteria for performance, Intake & Propelling Nozzle efficiency, Simple Turbo –JetCycles, Turbo Fan Engine, Turbo -prop engines, Turbo Shaft engines, Thrustaugmentation.

UNIT-IV

Prediction of Performance of Simple Gas Turbine, Methods for Improving Part–loadPerformance, Matching Procedure for Turbo -fan Engines, Transient behaviour of GasTurbines, Performance Deterioration and principle of control system.

UNIT-V

Rocket Propulsion-Classification, Operation, Performance, Ramjet Engines.

REFERENCES:

1. Saravanamootoo, H.I.H., & Rogers, G.F.C., “Gas Turbine Theory” PersonEducation(Singapore) Pvt. Ltd.., Indian Branch, New Delhi 2001.
2. Somasundaram S.L., “Gas Dynamics & Jet Propulsion”, New Age International (P)Ltd., New Delhi, 1996
3. Barlit V., “Lecture Notes Delivered at Bharat Heavy Electricals Ltd.”, Vol.I & Vol.II, 1966.
4. Canady G., “Theory of Turbomachines” McGraw Hill Book Co., N.Y. 1964
5. Jain J.K., “Gas Turbine Theory & Jet Propulsion” Khanna Publisher, Delhi 1995.
6. Yahya S.M., “Gas Turbine Theory”, New Age International Publishers, New Delhi 1982.
7. Ganeshan, V., “Gas Turbine”, Tata McGrawHill, 1999.

Semester	:	1st M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Gas Turbine and Jet Propulsion Laboratory
Code	:	MTDSCME114

LIST OF EXPERIMENTS

1. To study about the operation of Open cycle and Closed Cycle Gas Turbine Engines.
2. To estimate the performance of Gas Turbine Engine.
3. To study about the construction and operation of Turbojet Engine.
4. To study about the construction and operation of Turbofan Engine.
5. To study about the construction and operation of Ramjet Engine.
7. To estimate the performance of Combustion Chamber of Gas Turbine Engine.
8. To estimate the performance of De-Laval Nozzle.
9. To study about the construction and operation of Rocket Engines.
10. To study about the matching procedure of Turbofan Engines.
11. Part-load Performance estimation of Gas Turbine.

LIST OF EQUIPMENTS

1. Gas Turbine Performance Test Setup
2. Combustion Chamber Test Setup
3. De-Laval Nozzle Test Setup.
4. Gas Turbine Part-load Performance Test Setup

Semester	:	1st M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Fluid Dynamics Laboratory
Code	:	MTDSCME115

LIST OF EXPERIMENTS

1. To study Navier Stokes equation and its applications in engineering.
2. To study the transition from laminar to turbulent flow and to determine the lower critical Reynold's number.
3. To calculate the velocity of the flow through pipe and determine the shear stress distribution.
4. To study about the Conformal Transformation.
5. To study Thin Aerofoil Theory.
6. To study flow separation and vortex shedding over an Aerofoil.
7. To study the functioning of Laser Doppler Anemometer.
8. To study the construction and working of Thermal anemometers.
9. To study the functioning of P-I velocimeter.
10. To study grid generation techniques in CFD.

LIST OF EQUIPMENTS

1. Laser Doppler Anemometer.
2. Thermal anemometers.
3. P-I velocimeter.

CBCS Scheme of Teaching & Examination
M. TECH 2nd SEMESTER TURBO MACHINERY

S.N.	Code	Subject	Periods per week			Scheme of marks		Total Credit
			L	T	P	ESE	IM	
1.	MTDSCME210	Advanced Gas Dynamics	3	-	-	70	30	3
2.	MTDSCME211	Thermal Turbo Machines	3	-	-	70	30	4
3.	MTDSCME212	Hydro Turbo Machines	3	-	-	70	30	3
4.	MTDSCME213	Computational Fluid Dynamics	3	-	-	70	30	4
5.	MTPDSEXXX	Professional Elective-I	3	-	-	70	30	3
6.	MTDSCME214	Gas Dynamics Lab	-	-	2	30	20	2
7.	MTDSCME215	CFD Lab	-	-	2	30	20	2
Total			**15**	**-**	**4**	**410**	**190**	**21**

L – Lecture, T – Tutorial, ESE – End Semester Examination,
P – Practical, IM – Internal Marks (Include Class Test & Teacher's Assessments)

Semester	:	2nd M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Advanced Gas Dynamics
Total Theory Periods	:	45
Total Tutorial Periods	:	15
Code	:	MTDSCME210

UNIT-I INTRODUCTION

Review of fundamentals - Isentropic, adiabatic, Fanno line and Rayleigh line flows. Beltrami flows-Cylindrical stream surfaces-Axisymmetric Beltramic flows -free vortex type-forced vortex type and with constant flow angle-Mass flow rate through annulus - Chocking of flow through annulus. Potential flows -Absolute potential flows - flow equations.

UNIT-II NORMAL AND OBLIQUE SHOCKS

Normal shock-Governing equations-strength of shock waves- shocks in nozzles.

Oblique shocks- Theoretical analysis-governing equation-Rankine-Hugonoit relations-Prandtl's relation- Strong and weak shocks-oblique shock tables-Mach angles-Mach waves-Prandtl- Meyer expansion-Shock polar diagram- Flow around a corner-Hodograph method for the solution of two-dimensional flows.

UNIT-III SUPERSONIC FLOWS

Supersonic flows-Method of characteristics one and two dimensional isentropic flows-two dimensional, irrotational, isentropic, supersonic flow-Design of curved passages-supersonic nozzles-Supersonic cascades

UNIT-IV AXI-SYMMETRIC FLOWS

Axi-symmetric flows in rotating and stationary passage - Geometry of blade surfaces - Equilibrium conditions of flow - Influence of conditions at leading edge of blades - Flow conditions at rotor inlet and at rotor outlet - Flow in rotors with arbitrary blades - Methods of solution - correction for finite spacing and thickness of blades - Experimental results.

UNIT-V FLOW TYPES

Quasi two-dimensional flows in Turbo machines-Quasi two dimensional flows on surface of revolution-Irrotational flows on cylindrical stream surfaces-Blade force and circulation - systems of vortex lines as replacement for cascades - Axial cascades replaced by vortex sheet -Biot-Savart's law applied to vortex system for cascade with non -radial blades.

TEXT BOOK

1. Aerothermodynamics and flow in Turbo machines, Vavra, M.H., John Wiley, 1960.
2. The dynamics and thermodynamics of compressible fluids, Vol. I & II, Shapiro A.H., Ronald Press, 1965.

REFERENCES

1. Axial flow compressors - Horlock J.H., Butter worth London, 1973.
2. Axial flow turbines - Horlock J.H., Butter worth, London, 1973.
3. Mathematical theory of compressible fluid flow - Richard Von Mosses -Academia Press. N.Y., 1958.

Semester	:	2nd M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Thermal Turbo Machines
Total Theory Periods	:	45
Total Tutorial Periods	:	15
Code	:	MTDSCME211

UNIT-I RADIAL FLOW COMPRESSORS

Radial flow compressors- Energy transfer-Slip-Pressure coefficient- Isentropic efficiency-Effect of compressibility and pre-whirl-Diffuser-Non- dimensional parameters- surging- choking-performance characteristics.

UNIT II AXIAL FLOW COMPRESSORS

Axial flow compressors-Velocity triangles-Blading-number and type of stagings - Air and blade angles- Degree of reaction- Losses-Radial equilibrium and actuator disc theory performance characteristics.

UNIT-III STEAM TURBINES AND GAS TURBINES

Steam turbines - Types- Classification - constructional details of different types of steam turbines. **Gas turbines** -Types - Classification- Gas turbines engine and its components –constructional details of components - working principles of different components. Axial flow turbines (Impulse and Reaction) - Velocity triangles.

UNIT-IV TURBINE POWER CYCLES AND PERFORMACE

Power Cycles -Basic steam and gas turbine power cycles -Analysis-Efficiencies -Thermodynamic methods of improving the cycle efficiencies -Heat rate and steam rate calculations. Turbine speed - Number of stages and stage work - Gas angles and blade angles. Losses in turbines - Reheat factor and condition curve - constant stage efficiency - forms of actual condition curve - Turbine total wheel speed. Partial admission turbines - losses - Applications – performance estimation.

UNIT-V COMBUSTION CHAMBERS

Gas turbine combustion chambers - Requirements - Flame stabilization-combustion efficiency - fuel injection and atomization - Different types of combustors. Gas turbine power plant matching characteristics.

TEXT BOOKS:

1. Steam & Gas Turbines - Lee J.F. - McGraw Hill, 1962.
2. Theory of gas turbines - Cohen and Rogers Longman, 1974.

REFERENCES:

1. Steam turbines - Theory and Design - Shlyakhin. P., Peace Publishers, Moscow, (Translated from Russian by A. Jagamohan), 1965.
2. Fans - Eck B., Pergaman, 1972.
3. Axial flow turbines - Horlack, H.H., Butter worth, London, 1973.

Semester	:	2nd M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Hydro Turbo machines
Total Theory Periods	:	45
Total Tutorial Periods	:	15
Code	:	MTDSCME212

UNIT-I ROTODYNAMIC PUMPS AND AXIAL FLOW PUMPS

Rotodynamic pumps - pump parameters - similar pumps - non-dimensional Parameters - Specific speed - pump classification - different types - Ranges of operation.

Axial flow pumps-Constructional details-pump casing-guide system-Impeller -blade adjusting mechanism-diffuser-bearings-blade profiles-Aerofoil theory- estimation of blade lift and pump head losses– Performance Characteristics - cavitation.

UNIT-II CENTRIFUGAL PUMPS

Centrifugal pumps-radial and mixed flow-constructional details–Inlet passage -Suction spiral-impeller-Recuperator-Vaned diffuser-multistage pumps-return passage-internal leakage-Wearing ring-axial thrust- Balancing devices-Self priming arrangements-bearings and seals–Basic theory-number and shape of blades-blade loading-Head slip–Correction factors-pre-rotation-off-design performance-flow in the volute-flow in the diffuser and return passage-losses -hydraulic losses-volumetric losses- disc friction-mechanical losses-estimation of axial thrust–pump characteristics-stable operation-parallel operation of pumps-pumps in pipe systems-cavitations- NPSH.

UNIT-III BASICS OF HYDRAULIC TURBINES

Hydraulic turbines-basic parameters-principles of similarity–model turbines-Unit quantities and specific speed classification range of utilization- Constructional details of water turbines-Reaction turbines-propeller-Kaplan, bulb and Francis turbines-Inlet passage-Spiral casing-speed ring guide apparatus–casing draft tube-pelton wheel-distributor-nozzle-needle regulator –deflector bucket-braking jet.

UNIT-IV REACTION TURBINE AND PELTON WHEEL

Basic theory of reaction turbine-Velocity triangles and their correction-aerofoil theory-flow through different flow passages-volute, guide apparatus, runner and draft tube-hydraulic, volumetric and mechanical losses-energy balance- regulation of discharge-off-design performance-Forces and moments of guide vanes and adjustable blades of runner–axial thrust-cavitation in turbines- Thoma's coefficient-Location of turbine above the tail race. Theory of pelton wheel-action of jet on the buckets-flow on bucket surfaces-Hydrodynamic forces and torque on the runner-losses–energy balance.

UNIT-V TESTING OF PUMPS AND TURBINES

Testing of pump-test rig-standard instrumentation-operational characteristics. Testing of model turbines - test rigs- universal characteristics- separation of losses- Cavitation characteristics.

TEXT BOOKS:

1. Hydraulic Turbines - Nechlepa, M., Constable and Co., 1957.
2. Centrifugal and axial flow pumps - Stepanoff A.J., John Wiley 1962.

REFERENCES:

1. Impeller pumps - Lazarkieniz and Torskolanski, Pergamon Press, 1965.
2. Hydroelectric engineering practice - Vol. II, Editor Brown JG. 1958.
3. A treatise on applied hydraulics - Addison, H., Chapman and Hall, 1954.

Semester	:	2nd M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Computational Fluid Dynamics
Total Theory Periods	:	45
Total Tutorial Periods	:	15
Code	:	MTDSCME213

UNIT-I REVIEW OF GOVERNING EQUATIONS FLUID FLOW & HEAT TRANSFER

Conservation of Mass, Newton's Second Law of Motion, Expanded Forms of Navier stokes equations, Conservation of Energy Principle; Special Forms of the Navier Stokes Equations, Classification of Second order Partial Differential Equations, Initial and Boundary Conditions, Governing Equations in Generalized Coordinates.

UNIT-II FINITE DIFFERENCE, DISCRETIZATION, CONSISTENCY, STABILITY AND FUNDAMENTAL OF FLUID FLOW MODELING

Elementary Finite Difference Quotients, Basic Aspects of Finite Difference Equations, Errors and Stability Analysis, Some Nontrivial Problems with Discretized Equations, Applications to Heat Conduction and Convection.

UNIT-III SOLUTION OF VISCOUS INCOMPRESSIBLE FLOWS BY STREAM FUNCTION –VORTICITY FORMULATION

Two Dimensional Incompressible Viscous Flow, Incorporation of Upwind Scheme, Estimation of Discretization Error, Application to Curvilinear Geometries, Derivation of Surface Pressure and Drag.

UNIT-IV SOLUTION OF NAVIER -STOKES EQUATIONS FOR INCOMPRESSIBLE FLOWS USING MAC AND SIMPLE ALGORITHMS

Staggered Grid, Solution of the Unsteady Navier -Stokes Equations, Solutions of Energy Equation, Formulation of the Flow Problems, Simple Algorithm.

UNIT-V INTRODUCTION TO FVM

Introduction to FVM: Integral Approach, Discretization & Higher order scheme

TEXT BOOKS:

1. Anderson D.A., Tannehill J.C., Pletcher R.H., Computational Fluid Mechanics and Heat Transfer, Hemisphere Publishing Corporation, New York, U.S.A. 1984.
2. Anderson J.D., Jr., Computational Fluid Dynamics McGraw Hill, Inc New York, 1996.
3. H. K.Versteag and W. Malalsekara, "An Introduction to Computational Fluid Dynamics", Longman, 1995.

REFERENCES:

1. Murlidhar K. Sunderarajan T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 2003.
2. Ankar S.V., "Numerical Heat Transfer and Flow" Hemisphere Publ., Corporation, 1985.
3. Sturt P.A., "Introduction to Numerical Methods", the Macmillan Company, London, 1985.
4. Pratap R., "Getting Started with MATLAB", Sounders College Publ. 1995.
5. Carnahan B., "Applied Numerical Methods", John Wiley & Sons 1969.

Semester	:	2nd M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Gas Dynamics Lab
Code	:	MTDSCME214

LIST OF EXPERIMENTS

1. To study Navier Stokes equation and its applications in engineering.
2. To study the transition from laminar to turbulent flow and to determine the lower critical Reynold's number.
3. To calculate the velocity of the flow through pipe and determine the shear stress distribution.
4. To study about the Conformal Transformation.
5. To study Thin Aerofoil Theory.
6. To study flow separation and vortex shedding over an Aerofoil.
7. To study the functioning of Laser Doppler Anemometer.
8. To study the construction and working of Thermal anemometers.
9. To study the functioning of P-I velocimeter.
10. To study grid generation techniques in CFD.

LIST OF EQUIPMENTS

1. Laser Doppler Anemometer.
2. Thermal anemometers.
3. P-I velocimeter.

Semester	:	2nd M. Tech Course
Branch	:	Turbo Machinery
Subject	:	CFD Lab
Code	:	MTDSCME215

LIST OF EXPERIMENTS

1. To study about the isentropic flow through the C-D nozzle.
2. To study about Beltrami flow.
3. To study about the formation of Normal shock waves.
4. To study about the formation of Oblique shock waves.
5. To study about Prandtl's Mayer Expansion process.
6. To study about the Axi-symmetric flows in rotating and stationary passages.
7. To study about performance of various types of supersonic nozzles and Supersonic cascades.
8. To study about the Shock polar diagram and Hodograph.

Scheme of Teaching & Examination
M. TECH 3rd SEMESTER TURBO MACHINERY

III - Semester

S.N.	code	Subject	Periods per week			Scheme of marks		Total Credit
			L	T	P	ESE	IM	
1.	MTPDSEXXX	Professional Elective-II	3	-	-	70	30	4
2.	MTPDSEXXX	Professional Elective-III	3	-	-	70	30	3
3.	MTDSCME310	Turbo Machine Design Lab	-	-	2	30	20	2
4.	MTPR311	PROJECT WORK PHASE – I	-	-	18	140	60	12
Total			**6**	**0**	**20**	**310**	**140**	**21**

P – Practical, IM – Internal Marks (Include Class Test & Teacher's Assessments)
L – Lecture, T – Tutorial, ESE – End Semester Examination,

Semester	:	3rd M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Turbo Machine Design Lab
Code	:	MTDSCME310

LIST OF EXPERIMENTS

1. To carry out flow simulation for the supersonic flow over a flat plate.
2. To carry out flow simulation for turbulent flow in a pipe.
3. Flow Simulation over a circular cylinder with circulation effect.
4. Generation velocity profile for laminar flow
5. Generation of velocity profile for turbulent flow
6. Nussent number determination for a flow with constant it edition
7. Nussent number determination for a flow with heat edition at constant temperature
8. Simulation of flow over a car body.
9. Simulation of supersonic flow over an aircraft.
10. Determination of drag for a flow over a body
11. Analysis of 2-D transient heat flow over a plate
12. To study about different K-E models.
13. Friction factor for laminar flow
14. Friction factor for turbulent flow
15. Shear stress distribution for a flow in horizontal duct
16. To study about Navier-Stoke's Equation and various methods for its solution.
17. To study about various Grid-less techniques used in CFD.
18. To study about Moving Mesh and Auto-Mesh techniques.
19. To study about species transport and energy transport equation for combustion analysis.

LIST OF EQUIPMENTS

1. Computers with minimum 1 GB RAM, Pentium-IV Processor,
2. Ansys Fluent and Gambit packages,
3. ANSYS- 12 with Fluent and CFX,
4. UPS 10 KVa 3-Phase.

MATS UNIVERSITY, RAIPUR

Semester	:	3rd M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Project Work Phase – I
Code	:	MTPR311

The objective of the phase – I of the student's project work is to prepare themselves to undertake lively project which will found end application to the industry /society. Preparation for the project work involve

- ✓ The project for M. Tech should be carried by individual student.
- ✓ Make a preliminary survey and data collection or literature review of the project proposed in the next semester.
- ✓ Conduct a thorough literature survey and publish or present a paper of the proposed work in any one of the forthcoming International seminars/ conferences/journals.
- ✓ Plan for necessary supports, facilities, analytical tools and fixation of faculties /supervisors for the final semester project work.
- ✓ Partial work of the project is to be carried out in Phase-I and remaining in Phase-II which leads to the Thesis submission at the end of the project work.
- ✓ Project should be research oriented and at least two papers should be presented/accepted in the International Journals for the Thesis submission.

Scheme of Teaching & Examination
M. TECH 4th SEMESTER TURBO MACHINERY

S.N.	Subject Code	Subject	Periods per week			Scheme of marks		Total Marks
			L	T	P	ESE	IM	
1.	MTPR410	Project Work Phase – II	-	-	36	315	135	450
		Total	**-**	**-**	**36**	**315**	**135**	**450**

L – Lecture, T – Tutorial, ESE – End Semester Examination,

P – Practical, IM – Internal Marks (Include Class Test & Teacher's Assessments)

Semester	:	4th M. Tech Course
Branch	:	Turbo Machinery
Subject	:	Project Work Phase – II
Code	:	MTPR410

The objective of the project work is to enable the students to work individually on a project involving theoretical and experimental studies related to the branch of study. Every project work shall have a guide who is the member of the faculty of the institution. Students can opt for the co-guide from industries/ other colleges to get the necessary supervision. Six periods per week shall be allotted in the time table and this time shall be utilized by the students to receive the directions from the guide, on library reading, laboratory work, computer analysis or field work as assigned by the guide and also to present in periodical seminars on the progress made in the project.

Each student shall finally produce a comprehensive report in the form of Thesis covering background information, literature survey, problem statement, project work details and conclusion. This final report shall be typewritten form as specified in the guidelines. It is mandatory that the project selected should be research oriented and at least two papers/articles related to the project work should be published/ accepted for publication in the international journals for Thesis submission.

The continuous assessment shall be made as prescribed by the regulation.