

 THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA सयोजिरावसुन्दरम्	Mechanical Engineering Department Faculty of Technology & Engineering The M. S. University of Baroda, Vadodara, Gujarat, India-390 001 Website: http://www.msubaroda.ac.in		
Subject: Advanced Heat and Mass Transfer (MEC 2141)			
Specialization: Jet Propulsion and Gas Turbine Plants			
Teaching Scheme: Lectures: 4 Hours per Week Practicals/Termwork: 2 Hours per Week	Examination Scheme: Theory Paper : 100 Marks PR/TW/Viva : 50 Marks Total : 150 Marks	Page : 1 of 1	
		Academic Year : 2003-04	
		M. E. Part - I	

Syllabus

1. Review of Basic Equations and Steady State

Conduction:

General three-dimensional heat conduction equation, Boundary conditions.

Steady one dimensional heat conduction through simple and composite plane, cylindrical and spherical walls without heat generation, Effect of variable thermal conductivity, Critical thickness of insulation for cylindrical spherical systems. Steady one dimensional heat conduction through plane wall, hollow cylinder, solid cylinder and solid sphere with uniform heat generation, Heat flow through piston crown, buried cables, various heat sources.

Heat transfer from finned surfaces, general equation, Efficiency and effectiveness of fins, conduction in cooling of turbine balding, optimum dimensions, comparison of fin materials.

Two-dimensional steady state heat conduction, Numerical and graphical methods, Analogical solution.

2. Unsteady State Heat Conduction:

Heating and Cooling with negligible internal resistance, Temperature-time response of thermocouple, Heating and cooling with negligible surface resistance, Transient heat conduction in semi-infinite solids, Heating and Cooling of infinite plate with finite internal and surface resistance, Numerical and graphical analysis.

3. Convection:

Laminar and turbulent flow, Velocity (hydrodynamic) and thermal boundary layer. Dimensional analysis and dimensionless numbers for free and forced convection. Empirical relations and practical solution of free and forced convection in pipes, over plates and across cylinders and spheres, combined free and forced convection, combined free convection and radiation heat transfer.

4. Heat Exchangers:

Classification, overall heat transfer coefficient, LMTD method, LMTD correction factor for use with cross flow and multi-pass heat exchangers, effectiveness NTU method, Design considerations, and performance of heat exchangers, compact heat exchangers.

5. Radiation:

Laws of thermal radiation, Intensity of radiation, Lambert's cosine law, Radiant heat exchange between non-black bodies separated by a non-absorbing medium, Radiation shape factor, Radiation heat exchange through an absorbing medium, Radiation from gases, Radiation shields, Solar radiation, correction for radiation effects in temperature measurement.

6. Boiling and Condensation:

Film Condensation on tubes and tube banks, Film condensation in horizontal tubes, influence of the presence of non-condensable gases, Prop wise condensation, pool-boiling regimes, pool boiling correlation, forced convection boiling inside tubes.

7. Mass Transfer:

Modes of mass transfer, Diffusion (molecular or eddy) and convective mass transfer, Fick's laws and molecular diffusivity, Diffusion of gases and liquids through solids, Diffusion in liquids, equimolar counter-diffusion in gases, mass transfer coefficient, mass transfer in laminar and turbulent flow,

Combined heat and mass transfer wet and dry bulb thermometer.



Mechanical Engineering Department
Faculty of Technology & Engineering
The M. S. University of Baroda, Vadodara, Gujarat, India-390 001
Website: <http://www.msubaroda.ac.in>

Subject: Advanced Gas Dynamics I (MEC 2131)

Specialization: Jet Propulsion and Gas Turbine Plants

Teaching Scheme:

Lectures: 4 Hours per Week

Practicals/Termwork:

2 Hours per Week

Examination Scheme:

Theory Paper : 100 Marks

PR/TW/Viva : 50 Marks

Total : 150 Marks

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Academic Year : 2003-04

M. E. Part - I

Syllabus

1. Review of Fundamentals:

Types of flows, concepts of continuum and control volume, Generalized continuity, momentum and energy equations, velocity of sound and its importance, physical difference between incompressible, subsonic and supersonic flows, three reference speeds, dimensionless velocity M^* , concepts of static and stagnation parameters.

2. One Dimensional Isentropic Flow:

General features, working equations, choking in isentropic flow, operation of nozzles and diffusers under varying pressure ratios, performance of real nozzles, applications of isentropic flow.

3. Normal Shocks:

Introductory remarks, governing equations, Rankine – Huguenot, Prandtl and other relations, weak shocks, thickness of shocks, normal shocks in ducts, performance of convergent-divergent nozzle with shocks, moving shock waves, shock problems in one dimensional supersonic diffuser, supersonic pitot tube.

4. Flow in Constant Area Duct with Friction:

Governing equations, working formulas and tables, choking due to friction, performance of long ducts, Isothermal flow in long ducts.

5. Flow in Constant Area Duct with Heating and Cooling:

Governing equations, working formula and tables, choice of end states, choking effects, shock waves with changes in stagnation temperature.

6. Generalized One-Dimensional Flow:

Working equations, general method of solution, example of combined friction and area change, Example of combined friction and heat transfer.

7. Study of various flow visualization techniques.

8. Study of different types of wind tunnels, their design criteria.

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Subject: Advanced Thermodynamics (MEC 2135)			
Specialization: Jet Propulsion and Gas Turbine Plants			
Teaching Scheme: Lectures: 4 Hours per Week Practicals/Termwork: Nil	Examination Scheme: Theory Paper : 100 Marks PR/TW/Viva : Nil Total : 100 Marks	Page : 1 of 1	
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		M. E. Part - I	

Syllabus

1. Review of Basic Concepts:

System and surroundings, state parameters, thermal equilibrium and Zeroth law of thermodynamics, Thermodynamic equilibrium, Forms of energy and concept of work and heat, First law of thermodynamics – its applications and limitations.

2. Thermodynamic State Equations:

Perfect and real gases, state equation of perfect gas, Amagat's isothermals, Detailed study of Van der Waal, Dieterio, Berthelot, Redlich and Kwong and other state equations for real gases, compressibility factor and compressibility chart, generalized chart.

3. Second Law of Thermodynamic and Entropy:

Reversibility and irreversibility, statements of second law and their discussion Equivalence of Kelvin-Planck and Clausius statements, Carnot engine and Carnot refrigeration, Thermodynamic temperature scale and absolute zero temperature, Clausius theorem and Clausius inequality, concept and characteristics of entropy Principle of increase of entropy and entropy of universe.

4. Availability and Irreversibility:

Available energy lost work and degradation of energy, Maximum work, Availability – in a closed system and in a steady flow system, Gibbs function, Helmholtz function, Irreversibility and its measurement.

5. General Thermodynamic Relations:

General relations from energy equations, specific heat relations, relations for internal energy, enthalpy and entropy, Joule-Thomson coefficient, Applications of general thermodynamic relations to ideal gas, Van der Waal and other state equations.

6. Variable Specific heat:

Factors affecting specific heat, classical analysis, Plank's quantum hypothesis, methods for considering variation in specific heats, use of temperature-internal energy-entropy (t-u-s) chart for air.

7. Statistical Thermodynamics and Kinetic Theory of Gases:

Macrostate and microstate thermodynamic probability, Entropy and probability, entropy and lack of information, classical versus quantum statistics.

Kinetic theory of gases - Microscopic view of an ideal gas, mean and rms velocity, pressure exerted by a gas, kinetic interpretation of temperature, gas laws, Atomacy of gases and degrees of freedom, law of equipartition of energy, Distribution of velocity among the molecules and most probable velocity, Mean free path, Transport phenomena and associated properties.

 महाराजा सायजीराव विश्वविद्यालय वडोदरा	Mechanical Engineering Department Faculty of Technology & Engineering The M. S. University of Baroda, Vadodara, Gujarat, India-390 001 Website: http://www.msubaroda.ac.in		
Subject: Engineering Experimentation (MEC 2142)			
Specialization: Jet Propulsion and Gas Turbine Plants			
Teaching Scheme: Lectures: 4 Hours per Week Practicals/Termwork: 2 Hours per Week	Examination Scheme: Theory Paper : 100 Marks PR/TW/Viva : 50 Marks Total : 150 Marks	Page : 1 of 1	
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		M. E. Part - I	

Syllabus

- Generalized measurement system.
Basic detector transducer elements, intermediate modifying systems, terminating devices & methods.
- Analysis of Experimental data, uncertainty analysis by various methods, statistical analysis, Probability distribution, Gaussian error distribution, method of rejecting a reading, chi-square test of goodness of fits, methods of least squares, graphical analysis and curve fitting.
- Measurement of displacement, force and torque and strain measurements.
- Measurement of pressure, measurement of high & low pressures, dynamic characteristics of pressure measuring devices.
- Measurement of temperature, temperature measurements by mechanical effects, electrical effects and by radiation, transient response of thermal systems, temperature measurement in high speed flow.
- General-purpose electronic instruments.
- Recording techniques and Automatic control systems.
- Motion and vibration measurements, principles of seismic instruments, practical considerations of seismic instruments.

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Subject: Numerical Methods and Computer Programming (MEC 2134)			
Specialization: Jet Propulsion and Gas Turbine Plants			
Teaching Scheme: Lectures: 4 Hours per Week Practicals/Termwork: 2 Hours per Week	Examination Scheme: Theory Paper : 100 Marks PR/TW/Viva : 50 Marks Total : 150 Marks	Page : 1 of 1	
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		M. E. Part - I	

Syllabus

NUMERICAL METHODS

1. Algorithms, types, classification, complexity of Algorithms, efficiency of algorithms.
2. Gauss elimination algorithm, Cholesky method of matrix decomposition, Gauss-Siedel method, Newton Raphson, False position/Regular falsi, Eigen values and vectors, Jacobi method, Giben's method for Eigen values and vectors, power method.
3. Finite differences – forward, backward and central, ordinary and partial differential equations, extrapolation, Richardson's extrapolation, Interpolation.
4. Numerical differentiation - Euler's and Rungakutta methods.
5. Optimization, techniques, constrained and unconstrained.
6. Numerical Integration, Gauss quadratic, Newton Cotes, Webber rule.
7. Finite element methods - 1D, 2D problems, element types, interpolating polynomials, optimal fit by direct method, variational approach, weight residual approach.
8. Applications in turbo machinery, turbine blades, fan, blowers, rotating machinery, vibration problems.

COMPUTER PROGRAMMING

1. Fortran-77 and C, Syntax and control structures.
2. Subroutines and 1D, 2D and 3D arrays.
3. File input outputs, Random, Sequential.
4. Programming for Gauss Elimination, Cholesky, Jacobi algorithms, Newton-Raphson.
5. Banded matrix storage programming.

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Subject: Advanced Gas Dynamics II (MEC 2265)			
Specialization: Jet Propulsion and Gas Turbine Plants			
Teaching Scheme: Lectures: 4 Hours per Week Practicals/Termwork: Nil	Examination Scheme: Theory Paper : 100 Marks PR/TW/Viva : Nil Total : 100 Marks	Page : 1 of 1	
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		M. E. Part - II	

Syllabus

1. Two-dimensional subsonic and supersonic flows with small perturbations.
2. Conformal transformation and mapping of aerofoil sections, effect of circulation on potential flow past Joukowski aerofoil, Magnus effect.
3. Oblique shock, governing physical equations and general relations, shock polar diagram and auxiliary diagrams, strong and weak shocks, detached shock, interaction and reflection of shocks.
4. Pressure waves, general nature, finite, shock and detonation waves, compound waves, open and closed end reflection, partial reflection and transmission at a temperature discontinuity development of steep front in initially non-steep waves, Analysis of piston excited waves, shock tubes.
5. Method of characteristics, general principle of integration using method of characteristics, application to one dimensional isentropic progressive waves, application to steady two dimensional irrotational isentropic supersonic flows, Prandtl-Meyer expansion.
6. Boundary layer theory, Laminar and turbulent boundary layer concept, flow with Prandtl number unity and arbitrary Prandtl number, Integral equations of Laminar boundary layer, Differential and integral equations of Boundary layer, flow past a flat plate with turbulent Prandtl number of Unity. Elementary idea of boundary layer in tubes and in the presence of shock waves.

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Subject: Fuel Propellants and Combustion (MEC 2263)			
Specialization: Jet Propulsion and Gas Turbine Plants			
Teaching Scheme: Lectures: 4 Hours per Week Practicals/Termwork: 2 Hours per Week		Examination Scheme: Theory Paper : 100 Marks PR/TW/Viva : 50 Marks Total : 150 Marks	
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		M. E. Part - II	

Syllabus

1. Fundamentals of chemical Thermodynamics, Basic equations, third law of thermodynamics, Basic principles of Nuclear physics.
2. Fuels for Gas turbines and jet propulsion plants, liquid, solid and gaseous fuels and propellants, synthetic fuels, fuel ratings, nuclear fuels.
3. Basic concepts of combustion of gaseous, liquid and solid fuels for stationary and transportation gas turbine and jet propulsion plants.
4. Combustion chambers for jet propulsion and gas turbine plants, materials, cooling systems, maintenance.
5. Testing of fuels and recent trends in fuels and propellants for gas turbines, jet propulsion and rocket propulsion engines.

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Subject: Gas Turbine Plants (MEC 2261)			
Specialization: Jet Propulsion and Gas Turbine Plants			
Teaching Scheme: Lectures: 4 Hours per Week Practicals/Termwork: 2 Hours per Week		Examination Scheme: Theory Paper : 100 Marks PR/TW/Viva : 50 Marks Total : 150 Marks	
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		M. E. Part - II	

Syllabus

1. Review of Thermodynamic principles, Gas turbine cycles, main components of Gas turbine power plants, performance characteristics, typical Gas Turbine Plants.
2. Methods of improving efficiency and power output of gas turbine plants.
3. Design considerations of Centrifugal and axial flow compressors.
4. Types of Gas turbine plants and their theory of operation, design consideration of gas turbine plants.
5. Detailed study of main systems of gas turbine plants.
6. Selection of materials of Gas turbine components.
7. Trouble shooting, maintenance and actual performance evaluation of gas turbine plants.
8. Recent development of gas turbine plants.

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Subject: Jet Propulsion Plants (MEC 2262)			
Specialization: Jet Propulsion and Gas Turbine Plants			
Teaching Scheme: Lectures: 4 Hours per Week Practicals/Termwork: 2 Hours per Week	Examination Scheme: Theory Paper : 100 Marks PR/TW/Viva : 50 Marks Total : 150 Marks	Page : 1 of 1	
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		M. E. Part - II	

Syllabus

1. Basic theory of Jet & rocket propulsion devices and historical development.
2. Types of various jet propulsion plants like air screw, turboprop, turbojet, Ram jet, pulse jet, rocket propulsion, etc. and their comparative study.
3. Performance study of various jet propulsion devices from ideal and practical consideration.
4. Study and design considerations of main components of jet propulsion plants. Thrust augmentation devices and their thermodynamic analysis.
5. Combustion performance products of combustion and their properties.
6. Troubleshooting and maintenance of jet propulsion plants.
7. Rocket engines, of chemical propellant, liquid and solid propellants.
8. Recent advances in jet propulsion and Rocket propulsion devices.

	Mechanical Engineering Department Faculty of Technology & Engineering The M. S. University of Baroda, Vadodara, Gujarat, India-390 001 Website: http://www.msubaroda.ac.in		
Subject: Theory and Design of Turbomachinery Components (MEC 2264)			
Specialization: Jet Propulsion and Gas Turbine Plants			
Teaching Scheme: Lectures: 4 Hours per Week Practicals/Termwork: 2 Hours per Week	Examination Scheme: Theory Paper : 100 Marks PR/TW/Viva : 50 Marks Total : 150 Marks	Page : 1 of 1	
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Syllabus

1. Review of 3-D axisymmetrical flow, Vorticity, stream function, continuity, momentum and energy equations in different coordinate system.
2. Potential incompressible flow through axisymmetric channels, method of singularities, (sources, sinks, vortex rings) for channel profiling, compressibility effects, Duct exhaust systems, energy transfer in turbomachines, Euler's equation.
3. Axial flow compressor, cascade performances, losses, slach and Reynolds number effects, stage designing, blade profiles, Actuating disc approach, adjustable blades, fans, multistage compressors, stalling and surging phenomenon, performance characteristics of axial flow compressors.
4. Radial flow compressor, main design parameters, rotor design, vaneless and vaned diffusers, mixed flow compressors, two stage radial flow compressor, inter-cooling system, performance characteristics of radial flow compressors.
5. Axial flow turbine, cascade performance, loss mechanism, slach and Reynolds number effect, stage designing, blade profiles, forces acting and blade attachments, multistage turbine performance characteristics.
6. Radial flow turbine, Radial cascade performance, stage designing, adjustable nozzle blades, performance characteristics.
7. Turbine and compressor casing design.
8. Recent development in turbomachines.