Chhattisgarh Swami Vivekanand Technical University, Bhilai

SCHEME OF TEACHING AND EXAMINATION

M. E. Mechanical Engineering (Thermal Engineering)

II[nd] Semester

S. No.	Board of Study	Sub. Code	SUBJECT	PERIODS PER WEEK			SCHEME OF EXAM Theory/Practical			TOTAL MARKS	Credit L+(T+P) /2
				L	T	P	ESE	CT	TA		
1.	Mechanical Engg	564211 (37)	Modeling & Simulation of Thermal Systems	3	1	,	100	20	20	140	4
2.	Mechanical Engg	564212 (37)	Experimental Methods in Thermal Engineering	3	1	,	100	20	20	140	4
3.	Mechanical Engg	564213 (37)	Energy Management	3	1	,	100	20	20	140	4
4.	Mechanical Engg	564214 (37)	Refrigeration & Air Conditioning System Design	3	1	,	100	20	20	140	4
5.	Elective – II			3	1	,	100	20	20	140	4
6.	Mechanical Engg	564221 (37)	Instrumentation Lab	,	,	3	75	,	75	150	2
7.	Mechanical Engg	564222 (37)	Modeling & Simulation Lab	,	,	3	75	,	75	150	2
Total				**15**	**5**	**6**	**650**	**100**	**250**	**1000**	**24**

L – Lecture, T – Tutorial,
P – Practical, ESE, End Semester Exam,
CT, Class Test TA – Teacher's Assessment

Table, II

List of Electives, II

Elective - II			
S.No.	**Board of Study**	**Subject Code**	**Subject**
1	Mechanical Engg	564231 (37)	Boundary layer Theory
2	Mechanical Engg	564232 (37)	Two Phase Flow & Heat Transfer
3	Mechanical Engg	564233 (37)	Advance Gas Dynamics
4	Mechanical Engg	564234 (37)	Theory of Combustion & Emission

Note (1) - 1/4[th] of total strength of students subject is required to offer an elective in the college in a particular academic session.

Note (2) - Choice of elective course once made for an examination cannot be changed in future examinations.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: **II M.E (Thermal Engg.)** Branch: **Mechanical Engineering**
Subject: **Modeling and Simulation of Thermal Systems** Code: **564211 (37)**
Total Theory Periods**: 40** Total Tutorial Periods: **12**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: 02

Unit – I
Introduction to Modeling, concept of system, continuous and discrete systems, types of models, steps in simulation study.
Mathematical modeling of thermal processes, conservation laws, mass momentum & energy balance.

Unit – II
Dimensional analysis model development for various thermal processes and system.
Dynamics of thermo fluid system.

Unit-III
Simulation of thermal systems, steady state and dynamic simulation.

Unit-IV
Optimization of thermal systems, Introduction to optimization, formulation of objective function, constrained single and multivariable optimization, dynamic integer and geometric programming

Unit-V
Thermodynamic optimization, entropy generation minimization, application to internal and external flows, heat exchangers and other energy-equipment optimization.

Text Books:

1. Suryanarayana N.V. and Arici, Design and simulation of Thermal System, McGraw Hill Inc., 2001
2. Jaluria Y., Design and optimization of Thermal Systems, McGraw Hill Inc., 1997
3. Tsatsaronic G, Moran, M. Bejan, Thermal Design and Optimization, John Wiley & Sons Inc., 1995

References:

1. Gorden G, System Simulation, Prentice Hall Inc., 1978
2. Shannon RE, System Simulation : the Art and Science, Prentice Hall Inc., 1990
3. Close C.M. and Frederick D.K., Modeling and Analysis of Dyanmic Systems, John Wiley & Sons Inc., 2001
4. Jaluria Y and Torrance K.E, Computational Heat Transfer, Taylor & Francis, 2002

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: **II M.E (Thermal Engg.)** Branch: **Mechanical Engineering**
Subject: **Experimental Methods in Thermal Engineering** Code: **564212 (37)**
Total Theory Periods**: 40** Total Tutorial Periods: **12**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: 02

Unit – I

Significance of Measurement and Instrumentation : Introduction; generalized configuration and functional stages of measuring systems. The transducer and its environment; an overview; sensing process and physical laws.

Dynamic Response of Instruments: Mathematical model of a measuring system, response of general form of instruments to various test inputs; time-domain and frequency domain analysis. Elementary transfer functions and Bode plots of general transfer functions.

Unit– II

Errors in Measurement and Its analysis: Causes and type of experimental errors; systematic and random errors. Uncertainty analysis; computation of overall uncertainty; estimation for design and selection for alternative test methods.

Unit– III

Flow Measurement: Flow visualization, shadowgraph; schilieren and interferometric techniques; Pitot static tubes; hot wire anemometers; Laser Doppler velometer; flow measurements using coriolis effect.

Unit-IV

Temperature and Heat Flux Measurement: Thermoelectric sensors; electric resistance sensors; thermistors; radiations pyrometers; Temperature measuring problems in flowing fluids, dynamic compensation.

Unit – V

Data Acquisition and Signal Processing: System for data acquisition and processing; modules and computerized data system; digitization rate; time and frequency domain representation of signals, and Nyquist criterion.

A brief description of elements of mechatronics; modular approach to mechatronics and engineering design.

Text Books:

1. Doeblin, Measurements System Application and Design, 5th Ed., McGraw Hill, 2004
2. Trietly, Harry L, Transducers in Mechanical and Electronic Design, Marcel Dekker, CRC Press, 1986

References:

1. Marrangoni and Lienhard, Mechanical Measurement by Beckwith, 6th Edn, Prentice Hall, 2006
2. Eckert and Goldstein, Measurement in Heat Transfer, 2nd Ed., Sprinter, 1986
3. Goldstein R.J., Fluid Mechanics Measurement, Hemisphere Publishing Company, 1983

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: **II M.E (Thermal Engg.)** Branch: **Mechanical Engineering**
Subject: **Energy Management** Code: **564213 (37)**
Total Theory Periods**: 40** Total Tutorial Periods: **12**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: 02

Unit – I

Introduction : Energy Scenario, various forms of energy, energy management and its importance, recent trends in energy conservation.

Energy Auditing and Instrumentation: Definition, methodology, analysis of past trends (plan data), closing the energy balance, laws of thermodynamics, measuring instruments, portable and online instruments. Role of Instrumentation in Energy Conservation.

Unit – II

Energy Economics : Simple payback period, time value of money, IRR NPV, life cycle costing, cost of saved energy, cost of energy generated.

Unit-III

Monitoring and Targeting: Defining monitoring and targeting, elements of monitoring and targeting, data and information, analysis techniques, energy consumption, production, cumulative sum of difference.

Unit-IV

Energy Efficiency in Thermal Utilities: Boilers, steam systems, furnaces insulation and refractories, FBC boilers, cogeneration, waste heat recovery.

Unit-V

Energy Efficiency in Electrical Utilities : Electrical systems, electric motors, compressed air system, HVAC and refrigeration systems, fans and blowers, pumps and pumping systems, cooling towers, lighting system, diesel generating system.

Text Books:

1. Witte L.C., Schmidt P.S., Brown D.R., Industrial Energy Management and Utilization, Hemisphere, 1982
2. Gyftopoulos E.P., Industrial Energy Conservation Manuals, MIT Press, 1988
3. Dryden IGC, The Efficient Use of Energy, 2nd Ed., Butterworth Heinemann, 1982

References:

1. Capehart B.L, Turner W.C., Kennedy W.J., Energy Management Handbook, John Wiley and Sons, 1982
2. Technology Menu for Efficient Energy Use: Motor Drive Systems, Prepared by National Productivity Council and Centre for Environmental Studies, Princeton University, 1993
3. F. Krieth & RE West, Economics of Solar Energy & Conservation Systems, Vol. I & II, CRC Press,
4. D.A. Reay, Industrial Energy Recovery, Wiley

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: **II M.E (Thermal Engg.)** Branch: **Mechanical Engineering**
Subject: **Refrigeration & Air Conditioning System Design** Code: **564214 (37)**
Total Theory Periods**: 40** Total Tutorial Periods: **12**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: 02

Unit - I
Cooling and Heating Load Calculations:
Estimation of Solar Radiation : Introduction to cooling and heating load calculations, Solar radiation, Solar geometry, Calculation of direct, diffuse and reflected radiation using ASHRAE solar radiation model, Effect of clouds.
Solar Radiation Through Fenestration Ventilation And Infiltration
Need for fenestration in buildings and effects of fenestration on air conditioning systems, concepts of Solar Heat Gain Factor (SHGF) and Shading Coefficient, calculation of shaded area of fenestrations, Need for ventilation and recommended ventilation rates, Infiltration and causes for infiltration, Estimation of heat transfer rate due to infiltration and ventilation.
Heat Transfer Through Buildings - Fabric Heat Gain/Loss
General aspects of heat transfer through buildings, one-dimensional, steady state heat transfer through homogeneous, non-homogeneous walls, opaque walls and roofs with suitable initial and boundary conditions, semi-empirical methods based on Effective Temperature Difference or Cooling Load Temperature Difference, discuss the physical significance of decrement and time lag factors and present typical tables of CLTD for walls and roof.

Unit - II
Selection of Air Conditioning Systems:
Introduction to thermal distribution systems and their functions, Selection criteria for air conditioning systems, Classification of air conditioning systems, Working principle, advantages, disadvantages and applications of all air systems, eg. single duct, constant volume, and single/multiple zone system, single duct, dual duct, constant & variable air volume (VAV) systems, outdoor air control in all air systems, advantages/disadvantages & applications of all air systems, working principle, advantages, disadvantages and applications of all water systems, air-water systems, working principle, advantages, disadvantages and applications of unitary refrigerant based systems

Unit - III
Transmission of Air in Air Conditioning Ducts:
Air Handling Unit (AHU) and its functions, need for transmission aspects of air in air conditioning, airflow through air conditioning ducts, Bernoulli and modified Bernoulli equations, Static, dynamic, datum and total head, Fan Total Pressure (FTP) and power input to fan, estimation of pressure loss through air conditioning ducts,, Estimation of frictional pressure drop of circular and rectangular ducts using friction charts and equations, Estimation of dynamic pressure drop in various types of fittings, Static regain

Unit - IV
Design of Air Conditioning Ducts:
Important requirements of an air conditioning duct, General rules for duct design, Classification of duct systems, Commonly used duct design methods, Principle of velocity method, Principle of equal friction method, Principle of static regain method, Performance of duct systems, System balancing and optimization, Introduction to fans and fan laws, Interaction between fan and duct system.
Ventilation for Cooling
Use of ventilated air for cooling of buildings and cooling of occupants, comparison between natural ventilation and mechanical ventilation, characteristics of natural ventilation and estimation of airflow rate due to wind and stack effects, general guidelines for natural ventilation and forced ventilation using electric fans, interior air movement using interior fans, unit ventilators, whole house fans and solar chimneys.

Unit - V

Solar Refrigeration:

Potential and scope of solar cooling, Types of solar cooling systems, solar collectors and storage systems for solar refrigeration and air-conditioning, solar operation of vapor absorption cycle, temperature concentration diagram, enthalpy concentration diagram, steady flow process with binary mixtures, Energy balance for various components of vapor absorption cycle, Analysis of absorption system using concentration chart.

Text Books:

1. Stooker W.F, Refrigeration And Air Conditioning, Tata McGraw-Hill
2. C.P.Arora, Refrigeration And Air Conditioning
3. Ahmadul Ameen, Refrigeration And Air Conditioning

References:

1. Shan K. Wang, Hand Book of Air Conditioning and Refrigeration
2. Air conditioning design Hand Book, Carrier Corporation, McGraw Hill,
3. ASHRAE Hand books
4. Climatological and solar Data for India, Sarita Prakashan, CBRI

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: **II M.E (Thermal Engg.)** Branch: **Mechanical Engineering**
Subject: **Boundary Layer Theory** Code: **564231 (37)**
Total Theory Periods**: 40** Total Tutorial Periods: **12**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: 02

Unit – I

Introduction : Ideal and real fluids, the concept of boundary layer Navier – Stokes equations, the limiting cases of layer and small Reynolds number, energy equation.

Laminar Boundary Layer Equation: Two dimensional equations; displacement and momentum thickness; general properties of the boundary layer equations; skin friction.

Unit – II

Similarity Solutions: Wage flow and its particular cases; flow past a cylinder; two dimensional inlet flow in straight channel.

Approximate Methods: Karman-Pohthausen methods; numerical methods Axially symmetrical boundary layer Circular jet; body of revolution; Manglers transfixion

Unit – III

Axially Symmetrical Boundary Layer: Circular jet; body of revolution; Manglers transfixion

Boundary Layer Control: Different methods, flow over a flat plate with uniform section.

Unit – IV

Turbulent Boundary Layer: Two-dimensional equation; prandtl's misusing layer karman's hypothesis universal velocity distribution; flow over a flat plate; skin friction drag.

Unit – V

Thermal Boundary Layers: Two-dimensional equations forced flow over flat plate at zero in advances, national flow over a vertical plate.

Text Books:

1. Schlichting, Boundary Layer Theory, Springer-Verlag, 2004
2. Rozenhead, Laminar Boundary Layers, Dover Publications, 1988
3. Hinze, Turbulence, McGraw Hill, 1975

References:

1. Kays and Crawford, Convective Heat & Man Transfer, McGraw Hill, 1980
2. Wellty, Wicks & Wilson, Fundamentals of Momentum Heat and Mass Transfer, John Wiley & Sons, 1984
3. Goldstein, Modern Development in Fluid Dynamics, Vol. 5, Dover Publications, 1965

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: **II M.E (Thermal Engg.)** Branch: **Mechanical Engineering**
Subject: **Two Phase Flow & Heat Transfer** Code: **564232 (37)**
Total Theory Periods**: 40** Total Tutorial Periods: **12**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: 02

Unit – I
Introduction: Types of flow; volumetric concentration; void fraction; volumetric flux; relative velocity; drift velocity; flow regimes; flow maps; analytical models.
Homogeneous Flow: One dimensional steady homogeneous equilibrium flow; homogeneous friction factor; turbulent flow friction factor.

Unit – II
Separated Flow: Slip; Lockhart-Martinelli method for pressure drop calculation; pressure drop for flow with boiling; flow with phase change.

Unit – III
Drift Flow Model: General theory; gravity flows with no wall shear; correction to simple theory; Armond or Bankoff flow parameters.

Unit – IV
Boilers: Regimes of boiling; nucleation; gas nucleation in bulk liquid; growth of bubbles; motion at a heating surface; heat transfer rates in pool boiling; forced convection boiling; heat transfer correlations; maximum heat flux or burnout; metal boiling.

Unit – V
Condensation: Nusselt theory; boundary layer treatment of laminar film condensation; experimental results for vertical and horizontal tubes; condensation inside a horizontal tube.

Text Books:

1. Wallis, One Dimensional Two Phase Flow, McGraw Hill, 1969
2. Butterworth and Hewitt, Two Phase Flow and Heat Transfer, Oxford, 1977
3. Collier, Convective Boiling and Condensation, McGraw Hill, 1982
4. Rohsenow and others (ed), Handbook of Heat Transfer Fundamentals, McGraw Hill, 1998

References:

1. Tong, Boiling Heat Transfer and Two-Phase Flow, John Wiley (CRC Press), 1997
2. Whalley P.B., Boiling, Condensation and Gas-Liquid Flow, Clarendonpron, Oxford, 1987
3. Chisholm D, Two-phase flow in Pipe Lines and Heat Exchangers, Longman Inc. New York, 1987
4. Kakae and Veziroglu T.N., Two-phase Flows and Heat Transfer, Hemisphase Publising Corporation, 1977

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: **II M.E (Thermal Engg.)** Branch: **Mechanical Engineering**
Subject: **Advanced Gas Dynamics** Code: **564233 (37)**
Total Theory Periods**: 40** Total Tutorial Periods: **12**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: 02

Unit – I
Fundamental Aspects of Gas Dynamics: Introduction, Isentropic flow in a stream tube, speed of sound, Mach waves; One dimensional Isentropic Flow: Governing equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations.

Unit – II
Normal Shock Waves: Shock waves, stationary normal shock waves, normal shock wave relations in terms of Mach number; Oblique Shock Waves: Oblique shock wave relations, reflection of oblique shock waves, interaction of oblique shock waves, conical shock waves; Expansion Waves.

Unit – III
Prandtl Meyer flow, reflection and interaction of expansion waves, flow over bodies involving shock and expansion waves; Variable Area Flow: Equations for variable area flow, operating characteristics of nozzles convergent-divergent supersonic diffuses.

Unit – IV
Adiabatic Flow in a Duct with Friction: Flow in a constant area duct, friction factor variations, the Fanno line; Flow with Heat addition or removal: One-dimensional flow in a constant area duct neglecting viscosity, variable area flow with heat addition, one-dimensional constant area flow with both heat exchanger and friction, Generalized Quasi-One-Dimensional Flow: Governing equations and influence coefficients; solution procedure for generalized flow with and without sonic point;.

Unit – V
Two-Dimensional Compressible Flow: Governing equations, vorticity considerations, the velocity potential, linearized solutions, linearized subsonic flow, linearized supersonic flow, methods of characteristics.

Text Books:

1. Landau L.D. and Lifshitz, Fluid Mechanics, 2nd Edn. Butterworth-Heinemann, 1995
2. Liepmann H.W. and Roshko A, Elements of Gas Dynamics, Dover Pub., 2001

References:

1. Oosthuizen P.H. and Carscallen W.E., Compressible Fluid Flow, NY, McGraw-Hill, 1997
2. Saad M.A., Compressible Fluid Flow, 2nd Ed., Upper Saddle River, NJ: Prentice-Hall, 1993
3. White F.M., Viscous Fluid Flow, 2nd Ed. New York, McGraw Hill, 1991
4. Shapiro A.H, Compressible Fluid Flow 1 and 2, Hoboken N.J., John Wiley

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: **II M.E (Thermal Engg.)** Branch: **Mechanical Engineering**
Subject: **Theory of Combustion & Emission** Code: **564234 (37)**
Total Theory Periods**: 40** Total Tutorial Periods: **12**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: 02

Unit – I
Generation and nature of pollutants from various combustion sources, classification of pollutants, primary and secondary pollutants, Stationary and mobile sources, Significance of natural and artificial pollutants, Properties of major air pollutants

UNIT - II
Effect of combustion pollution on man, material and vegetation, Study of air pollution disasters of world, acid rains, ozone holes.

UNIT - III
Thermo chemistry of pollutant formation, stiochiometry, chemical thermodynamics, kinetics. Formation of CO, Sox, Nox, Thermodynamics of combustion, combustion of coal, oil, gas, natural gas, LPG.

UNIT - IV
Combustion pollution from IC Engines, Nature and extent of problem, Nitrogen Oxides, Kinetics of NO formation, Nox formation in SI and CI Engines, Carbon monoxides, unburned hydrocarbons emissions. Particulate emissions exhaust gas treatment, catalytic converters, three way catalysts, particulate traps.

UNIT - V
Control technology for particulate, for gaseous pollutants, for Sox, for Nox, for odour pollution, Meteorology and dispersion of pollutants, instruments for pollutant measurement and monitoring.
Legislation and emission standards.

Text Books:

1. Strehlow , Combustion Fundamentals, McGraw Hill
2. Glassman, Combustion, Academic Press
3. K.V.S.G Murli Krishna, Air Polution and Control, Kaushal and Co. Kakinada
4. Howard S Peavy, Environmental Engineering, McGraw Hill, Singapore

References:

1. Introduction to Combustion Phenomena by Taylor& Francis
2. Pollution control in process Industries by S P Mahajan, Tata McGraw Hill
3. Internal Combustion Engine Fundamentals by Heywood McGrawHill
4. Internal Combustion Engine Fundamentals by Ferguson Jhon Wiley

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: **II M.E (Thermal Engg.)** Branch: **Mechanical Engineering**
Subject: **Instrumentation Lab** Code: **564221 (37)**
Total Practical Periods**: 40**
Total Marks in End Semester Exam. : **75**

1. **Different methods of measuring different parameters viz. Temperature, Pressure, Air velocity, flow etc.**
2. **For above Data Acquisition System is to be used.**

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: **II M.E (Thermal Engg.)** Branch: **Mechanical Engineering**
Subject: **Modeling & Simulation Lab** Code: **564222 (37)**
Total Practical Periods**: 40**
Total Marks in End Semester Exam. : **75**

One Problem/ Minor Project will be allotted to each student related to subject taught in 2nd semester