MECHANICAL ENGINEERING
M.E. (HEAT TRANSFER AND ENERGY SYSTEMS)
(Four-Semester Course-Credit System- w.e.f. 2007-2008)

FIRST SEMESTER

Scheme of Instruction and Examination

Course No.	Name of the course	Periods per week		Exam (Hrs)	Max. marks		Credits
		Lec.	Lab		Exam	Sess.	
HT 101	Mathematical Methods in Engineering	4	—	3	70	30	4
HT 102	Numerical Analysis and Computer Techniques	4	—	3	70	30	4
HT 103	Advanced Fluid Mechanics	4	—	3	70	30	4
HT 104	Conduction and Radiation Heat Transfer	4	—	3	70	30	4
HT 105	Elective - I	4	—	3	70	30	4
HT 106	Measurements in Heat Transfer	4	—	3	70	30	4
HT 107	Thermo Fluids Lab	—	3	—	—	50	2
HT 108	Seminar	—	3	—	—	50	2
Total		24	6	—	420	280	28

Elective – I : A. Advanced Optimization Techniques B. Principles of Combustion
C. Renewable Energy Systems

SECOND SEMESTER

Scheme of Instruction and Examination

Course No.	Name of the course	Periods per week		Exam (Hrs)	Max. marks		Credits
		Lec.	Lab		Exam	Sess.	
HT 201	Thermal Environmental Control	4	—	3	70	30	4
HT 202	Convection Heat Transfer	4		3	70	30	4
HT 203	Principles of Energy Conversion	4	—	3	70	30	4
HT 204	Design of Thermal Equipment	4	—	3	70	30	4
HT 205	Boiling & Two Phase Flow Heat Transfer	4	—	3	70	30	4
HT 206	Elective – II	4	—	3	70	30	4
HT 207	Seminar	—	3	—	—	50	2
Total		24	3	—	420	230	26

Elective – II : A. Energy Conservation and Recovery Systems
B. Advanced Finite Element Analysis
C. Computational Fluid Dynamics

THIRD and FOURTH SEMESTER
Scheme of Instruction and Examination

Course No.	Name of the course	Periods per week	Duration of exam (hours)	Max. marks	Credits
				Exam	
HT 301	Project	12	—	Recommended/Not recommended	14

The prerequisite for submission of the ME thesis is that one should communicate his/her work to any referred journal or Publication in a conference.

FIRST SEMESTER

HT 101 MATHEMATICAL METHODS IN ENGINEERING

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Ordinary and partial differential equations - Fourier and Laplace transform - Vector calculus - Solution of linear equations - Eigen-value problems - Complex variables.

References:

1. Applied Mathematics for Engineering and Physicists by Pipes, L.A., McGraw Hill Book Co.
2. Advanced Calculus for Applications by Hildebrand, F.B., Prentice Hall Book Co.

HT 102 NUMERICAL ANALYSIS AND COMPUTER TECHNIQUES

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Numerical approximation - Numerical differentiation and integration, Solution of equations - Ordinary and partial differential equations - FORTRAN-IV language - Fundamentals and typical examples from fluid mechanics and Heat and Mass Transfer.

References:

1. Applied Numerical Methods by Carnhan, B., Luther, H.A. and Jo Wilkes, John Wiley and Sons.
2. Numerical Analysis by Hilderbrand.
3. Computer Programming in FORTRAN by Rajaraman, V., Prentice Hall Book Co.

HT 103 ADVANCED FLUID MECHANICS

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Ideal and non-ideal flows, General equations of fluid motion, Navier-Stokes equations and their exact solutions, Boundary layer theory, solutions to flow over external surfaces, flow thorough internal surfaces, integral methods, steady laminar and turbulent incompressible flows, Introduction to compressible viscous flows, governing equations, Fanno and Rayleigh lines, normal and oblique shocks

References:

1. Boundary layer theory, Schlichting by McGraw Hill
2. Foundations of fluid mechanics by Yuan, Prentice Hall
3. Turbulence, Bradshaw by Springer-Verlag

HT 104 CONDUCTION AND RADIATION HEAT TRANSFER

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Conduction heat transfer - Heat equation in Cartesian, cylindrical and spherical coordinates -boundary conditions - extended surfaces heat transfer - transient conduction - conduction with phase change - integral method, solidification and melting - numerical methods.
Radiation Heat Transfer - review of radiation principles - laws of thermal radiation - surface properties - radiative heat exchange among diffuse, gray and non-gray surfaces separated by non-participating media - gas radiation and radiation transfer in enclosures containing absorbing and emitting media - interaction of radiation with conduction and convection.

References:

1. Analysis of heat and mass transfer by Eckert and Drake, McGraw-Hill
2. Fundamentals of heat transfer by Grober, Erk and Grigull, McGraw-Hill
3. Fundamentals of heat transfer by Incropera and Hewitt
4. Heat conduction by Ingersol
5. Conduction heat transfer by Schneider, Eddison Wesley
6. Radiation heat transfer by Sparrow and Cess, McGraw-Hill
7. Radiation heat transfer by H.C. Hottel and A.F. Sarofin
8. Thermal radiation by Siegel and Howell.

Elective – I

(A) HT 105 ADVANCED OPTIMIZATION TECHNIQUES

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Geometric programming (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. Primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P), Complementary Geometric Programming (C.G.P)
Dynamic programming(D.P): Multistage decision processes. Concepts of sub optimization and Principal of optimality, computational procedure in dynamic programming calculus method and tabular methods. Linear programming as a case of D.P. and continuous D.P.
Integer programming(I.P): Graphical representation. Gomory's cutting plane method. Bala's algorithm for zero-one programming problem. Branch-and-bound method, Sequential linear discrete Programming, Generalized penalty function method.
Stochastic Programming (S.P.): Basic Concepts of Probability Theory, Stochastic Linear programming.
Non-traditional optimization techniques: Multi-objective optimization - Lexicographic method, Goal programming method, Genetic algorithms, Simulated annealing, Neural Networks based Optimization.

References:

1. Operations Research- Principles and Practice by Ravindran, Phillips and Solberg, John Wiely
2. Introduction to Operations Research by Hiller and Lieberman, Mc Graw Hill
3. Engineering Optimization - Theory and Practice by Rao, S.S., New Age International (P) Ltd. Publishers.
4. Engineering Optimization By Kalyanmanai Deb, Prentice Hall of India, New Delhi.
5. Genetic Algorithms - In Search, Optimization and Machine Learning by David E. Goldberg, Addison-Wesley Longman (Singapore) Pvt. Ltd.

Elective - I

(B) HT 105 PRINCIPLES OF COMBUSTION

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th — Ses. : 30 Exam: 70

Examination (Theory): 3hrs. — Credits: 4

Elective - I

(C) HT 105 RENEWABLE ENERGY SYSTEMS

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. — Ses. : 30 Exam: 70

Examination (Theory): 3hrs. — Credits: 4

HT 106 MEASUREMENTS IN HEAT TRANSFER

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. — Ses. : 30 Exam: 70

Examination (Theory): 3hrs. — Credits: 4

Analysis of experimental data: Causes and types of experimental errors, Error analysis on a commonsense basis, Uncertainty analysis, Statistical analysis of experimental data probability distributions, The Gaussian or normal error distribution, Probability graph paper, The Chi-square test of goodness of fit, Method of least squares, Standard deviation of the mean, Graphical analysis and curve fitting, General considerations in data analysis.

Basic electrical measurements and sensing devices - Transducers, The variable - Resistance transducers, The differential transformer (LVDT), Capacitive transducers, Piezoelectric transducers, Photoelectric effects, Photoconductive transducers, Photovoltalic cells, Ionization transducers, Magnetometer search coil: Hall-effect transducers.

Pressure measurement: Dynamic response considerations, Mechanical pressure - Measurement devices, Dead-weight tester, Bourdon-tube pressure gauge, Diaphragm and bellows gauges, The Bridgman gauge, Low-pressure measurement. The Mcleod gauge, Pirani thermal-conductivity gauge, The Knudsen gauge, The ionization gauge, The alphatron.

Flow measurement: Positive displacement methods flow - Obstruction methods, Practical consideration for obstruction meters, The sonic nozzle. Flow measurement by drag effects, Hot-wire and hot-film anemometers, Magnetic flow meters, Flow- visualization methods, The shadowgraph, The schlieren, The interferometer, The Laser Doppler Anemometer (LDA), Smoke methods, Pressure probes, Impact pressure in supersonic flow.

The measurement of temperature: Temperature scales. The ideal-gas thermometer, Temperature measurement by mechanical effect. Temperature measurement by electrical effects, Temperature measurement by radiation, Effect of heat transfer or temperature measurement, Transient response of thermal systems, Thermocouple compensation, Temperature measurements in high-speed flow.

Thermal and transport Property measurement: Thermal conductivity measurements, Thermal conductivity of liquids and gases, Measurement of viscosity, Gas diffusion, Calorimetry, Convection heat-transfer measurements. Humidity measurements, Heat-flux meters.

Thermal radiation measurements: Detection of thermal radiation, Measurement of emissivity, Reflectivity and transmissivity measurements, Solar radiation measurements.

References:

1. Experimental Methods for Engineers by Holman, J.P.
2. Mechanical Measurements by Thomas G. Beckwith, N. Newis Buck.
3. Measurements in Heat Transfer by Eckert and gold stein.

HT 107 THERMO-FLUIDS LABORATORY

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 50
Examination (Theory): 3hrs. Credits: 2

List of Experiments:

1. Heat transfer due to conduction.
2. Natural convection heat transfer from a horizontal cylinder.
3. Forced convection from a horizontal cylinder.
4. Combined convection and radiation.
5. Radiation errors in temperature measurement.
6. Heat transfer from extended surfaces.
7. Transient conduction.
8. Heat exchanger.

HT 108 SEMINAR

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 3Pr Ses. : 50
Credits : 2

The student has to give at least three seminars on relevant topics of his choice but related to Marine Engineering and Mechanical handling.

MODEL QUESTION PAPER-Mechanical Engineering
M.E. (HEAT TRANSFER IN ENERGY SYSTEMS)-I SEMESTER

HT 101 MATHEMATICAL METHODS IN ENGINEERING
(Four Semester-Credit System-w.e.f. 2007--2008)

Time : 3 Hrs. Max. Marks : 70

Answer any FIVE questions.
All questions carry equal marks.

1. a) Solve $\frac{dy}{dx} = \frac{x^3 + y^3}{xy^2}$.

   b) Solve $2\cos x \frac{dy}{dx} + 4y \sin x = \sin 2x$, given that $y = 0$ when $x = \pi/3$. Show further that the maximum value of $y = 1/8$.

2. a) Solve $(D^2 - 2D + 3)y = e^{-x} \sin x$.

   b) Solve simultaneous equations:

   $$\frac{dx}{dt} + 5x + y = e^t.$$
   $$\frac{dy}{dt} + 3y - x = e^{2t}.$$

3. Solve the following partial differential equations:

   a) $(x^2 - y^2 - z^2)p + 2xyq = 2xz$

   b) $p(1 + z^2) = q(z - a)$

4. a) Find the Laplace transform of

   i) $f(t) = \begin{cases} t, & 0 < t < 1 \\ 0, & t > 1 \end{cases}$ ii) $e^t\left(\cos 2t + \frac{1}{2}\sin 2t\right)$

   b) Find inverse transforms:

   i) $\frac{s}{(s+3)^2 + 4}$ ii) $\frac{1}{(s^2 + a^2)^2}$

5. a) Find the Fourier transform of

   $$f(x) = \begin{cases} 1 & \text{for } |x| < 1 \\ 0 & \text{for } |x| > 1 \end{cases}$$

   Hence evaluate $\int_0^\infty \frac{\sin x}{x} dx$.

   b) Find the Fourier sine transform of

   $f(x) = e^{-ax}$ $(a > 0)$

6. a) Find the directional derivative of $\phi = x^2yz + 2xz^2$ at the point (1, –2, –1) in the direction of the vector $2i - j - 2k$.

   b) Find the value of 'a' if the vector $(ax^2y + yz)i + (xy^2 - xz^2)j + (2xyz - 2x^2y^2)k$ has zero divergence. Find the curl of the above vector which has zero divergence.

7. a) Using the line integral, compute the work done by the force $\overline{F} = (2y + 3)i + xzj + (yz - x)k$ when it moves a particle from the point (0, 0, 0) to the point (2, 1, 1) along the curve $x = 2t^2$, $y = t$, $z = t^3$.

   b) Find the constant 'a' so that $\overline{V}$ is a conservative vector field. Where $\overline{V} = (axy - z^3)i + (a - 2)x^2j + (1 - a)az^2k$. Calculate its scalar potential and work done in moving a particle from (1, 2, –3) to (1, –4, 2) in the field.

8. a) Investigate for what values of λ, μ the equations have (i) no solution, (ii) unique solution, (iii) infinite number of solutions for $x + y + z = 6$; $x + 2y + 3z = 10$; $x + 2y + \lambda z = \mu$.

   b) Find the Eigten values and Eiven vectors of the matrix, $\begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$.

9. a) An incompressible fluid flowing over the xy plane has the velocity potential

$$\phi = x^2 - y^2 + \frac{x}{(x^2+y^2)^2}.$$

   Examine if this is possible and find a stream function ψ.

   b) Using Cauchy's integral formula, find the value of

$$\int_C \frac{z+4}{(z^2+2z+5)} dz$$

   where C is the circle $|z + 1 - i| = 2$.

MODEL QUESTION PAPER-Mechanical Engineering
M.E. (HEAT TRANSFER IN ENERGY SYSTEMS)-I SEMESTER

HT 102 NUMERICAL ANALYSIS AND COMPUTER TECHNIQUES

(Four Semester-Credit System-w.e.f. 2007--2008)

Time : 3 Hrs. Max. Marks : 70

Answer any **FIVE** questions choosing at least **TWO** from each Section.
All questions carry equal marks.

PART – A
(Numerical Analysis)

1. a) Find the root of the equation tan x + tan hx = 0 lying between 2.3 and 2.4 by using method of false position.

   b) Calculate the solutions of the system

   $x^2 + y^2 = 1.12$, $xy = 0.23$

   correct to three decimal places starting with initial approximation (1, 1).

2. a) Find the value of f(1.95) from the table of values:

x :	1.7	1.8	1.9	2.0	2.1	2.2	2.3
f(x) :	2.979	3.144	3.283	3.391	3.463	3.997	4.491

   b) If $F(n) = \sum_{x=n}^{10} f(x)$, find f(1) by using F(1) = 500426, F(4) = 329240, F(7) = 175212 and F(10) = 40365.

3. a) A rod is rotating in a plane. The following table gives the angle θ (radius) through which the rod has turned for various values of time t seconds.

t :	0	0.2	0.4	0.6	0.8	1.0	1.2
θ :	0	0.12	0.49	1.12	2.02	3.20	4.67

   Calculate the angular velocity and angular acceleration of the rod when t = 0.6 seconds.

   b) Estimate the length of the arc of the curve $3y = x^3$ from (0, 0) to (1, 3) by using Simpson's 1/3 rule taking 8 sub-intervals.

4. Find the Runge-Kutta method an approximate value of y at x = 0.8 from $\frac{dy}{dx} = \sqrt{x+y}$, y = 0.41 at x = 0.4 in steps of h = 0.1.

PART – B
(Computer Techniques)

5. a) Write a flow chart to fit a straight line y = mx + c for the given set of points (x_i, y_i), i = 1, 2, …, n.
   b) Which of the following are unacceptable as integer variables and why?
      i) NEXT ii) ALPHA iii) J + 329 iv) L124 v) N(3)M
   c) Locate errors, if any, in each unformatted I/O statement:
      i) READ *, FIRST, LAST, NEXT ii) READ *, INT.LOT, AREA
      iii) PRINT *, ID, WAGE, RATE iv) PRINT * A.B, C.D.
6. a) Write a program to determine whether A, B, C forms the sides of a triangle. If yes, what type of triangle that is (i) a equilateral triangle, (ii) isosceles triangle, (iii) right angle triangle. If no, print the message 'not a triangle'.
   b) Find out the output of the following program which use statement function:

```
      JF(M) = M**2 – 3 * M + 4
      K = 2
      L = JF(L – 3 * K) + K
      WRITE(*, 10)K, L, M
10    FORMAT(1X, 3(I10, 2X))
      STOP
      END
```

7. a) Write a computer program to solve differential equation $10\frac{dy}{dx} = x^2 + y^2$, y(0) = 1 in $0 \le x \le 2$ with h = 0.1 by Runge-Kutta method.
   b) Write a program which calculates the mean, mean deviation about mean, standard deviation for a given set of data.
8. Write short notes on any FOUR of the following:
   a) Flow charts.
   b) Dimension, common statements.
   c) Subroutines.
   d) Format statements.
   e) Different types of control statements.

MODEL QUESTION PAPER-Mechanical Engineering
M.E. (HEAT TRANSFER IN ENERGY SYSTEMS)-I SEMESTER

HT 103 ADVANCED FLUID MECHANICS
(Four Semester-Credit System-w.e.f. 2007--2008)

Time : 3 Hrs. Max. Marks : 70

Answer any FIVE questions.
All questions carry equal marks.

1. a) Describe acceleration of an ideal fluid element in Cartesian and cylindrical polar coordinates, given $\bar{q} = \bar{u}_i + \bar{v}_j + \bar{w}_k$ as velocity vector, where u, v and w are functions of x, y, z and t, where $u = x_i + 2y_j + 3z_k$; $v = 2x_i + 3y_j + 4z_k$; $w = 3x_i + 4y_j + 5z_k$.
   b) Determine the resultant of an uniform flow of an ideal fluid superimposed on a doublet. Determine the relationship between this flow and that of an ideal fluid past a circular cylinder.
2. a) Derive the Navier-Stokes equation of motion for an incompressible viscous fluid in Cartesian coordinate system.
   b) What do you understand by an exact solution of Navier-Stokes equation? Discuss briefly with suitable example of a fully developed in a pipe/ between parallel plates.
3. a) What do you understand by the term order of magnitude analysis? With the help of order of magnitude analysis deduce the boundary layer equations.
   b) Briefly describe the solution to the momentum integral equation for flow over a flat plate highlighting the important steps involved in the process.
   c) Find the boundary layer thickness using a third degree polynomial to solve the momentum integral equation.
4. a) Explain clearly the concepts of displacement thickness, momentum thickness, lift and drag with suitable examples.
   b) Discuss different methods of boundary layer control. Explain the significance of boundary layer suction in delying the transition from laminar to turbulent flow.
   c) Distinguish a steady flow from an unsteady flow with examples.
5. a) Water at 30ºC and atmospheric pressure flows through a smooth pipe of 5 cm ID. The flow is fully developed and is at the rate of 2 liters/sec. Calculate the friction factor, pressure drop over a length of 5 cm and thickness of the laminar sub-layer.
   b) Explain Prandtl's mixing length theory. Describe different zones of turbulent flow. Discuss the phenomenon of flow separation and the conditions associated with it in mathematical terms.
   c) What do you understand by the term Eddy Viscosity? Explain.
6. a) What is Mach number? Explain the limits of incompressibililty. Describe the pressure field due to a moving source of disturbances for subsonic, sonic and supersonic flow conditions.
   b) Describe the isentropic flow characteristics of the compressible flow through a converging diverging duct.
   c) Derive Bernoulli's equation for a compressible flow.
7. a) Discuss the Fanno line representation of constant area adiabatic flow on a h-s diagram. Explain its significance.
   b) Discuss Rayleigh line representation of constant area frictionless flow with heat transfer on a h-s diagram. Explain its significance.
   c) Show that there exist sonic conditions at the throat section of a converging diverging nozzle.

8. a) Describe a normal shock on a h-s diagram. Obtain the governing relation for a normal shock to evaluate Mach number M_2 downstream of a normal shock for a given upstream condition of M_1.

b) How do you estimate the effects of a moving shock wave with the help of relative velocity method

i) when the observer is stationary

ii) when the observer is located on the shock wave itself.

9. Write short notes on any FIVE of the following:

a) Source and sink.
b) Couette flow.
c) B.L. separation.
d) Free and forced vortex.
e) Drag on immersed bodies.
f) Stream lines, streak lines and path lines.
g) Reynolds transfer theorem.
h) Normal and oblique shocks.

MODEL QUESTION PAPER-Mechanical Engineering

M.E. (HEAT TRANSFER IN ENERGY SYSTEMS)-I SEMESTER

HT 104 CONDUCTION AND RADIATION HEAT TRANSFER

(Four Semester-Credit System-w.e.f. 2007--2008)

Time : 3 Hrs. Max. Marks : 70

Answer any FIVE questions.

All questions carry equal marks.

Use of Heat Transfer data book is permitted.

1. The temperatures on the two surfaces of a 20 mm thick steel plate (k = 50 w/mºC), having a uniform volumetric heat generation of 40×10^6 w/m^3, are 160ºC and 100ºC. Neglecting the end effects, determine the following: (i) the position and value of the maximum temperature and (ii) the flow of heat from each surface of the plate.

2. Explain any one method that you are familiar for solving two dimensional heat conduction problems.

3. One end of a rectangular straight fin is fixed to a wall of uniform temperature and the other end is insulated. The wall temperature is more than the surrounding atmospheric temperature. Derive an expression for temperature distribution and heat dissipation for the fin in standard form.

4. A hot cylinder ignot of 50 mm dia and 200 mm long is taken out from the furnace at 800ºC and dipped in water till its temperature fails to 500ºC. Then it is directly exposed to air till its temperature falls to 100ºC. Find the total time required for the ignot to reach the temperature from 800 to 100ºC. Take the following for ignot. k = 60 w/mºC, specific heat = 200 J/kgºC, density = 800 kg/m^3. Film coefficient in water = 200 w/m^{2}ºC, film coefficient in air = 20 w/m^{2}ºC, temperature of air or water = 30ºC.

5. a) Write a note on Planck's law of radiation.

b) Determine the rate of heat loss by radiation from a steel tube of outside dia 70 mm and 3 m long at a temperature of 227ºC if the tube is located in a brick conduit of square cross-section of 0.3 m side. The conduit temperature is 27ºC. Take effisivity for steel = 0.79 and for brick = 0.93.

6. A long cylindrical heater 25 mm in dia is maintained at 660ºC and has surface emissivity of 0.8. The heater is located in a large room whose walls are at 27ºC. How

much will the radiant transfer from the heater be reduced if it is surrounded by a 300 mm dia radiation shield of aluminium, having an emissivity of 0.2? What is the temperature of the shield?

7. A thermocouple indicates a temperature of 800ºC when placed in a pipeline where a hot gas is flowing at 870ºC. If the convective heat transfer coefficient between the thermocouple and gas is 60 w/m^{2}ºC, find the duct wall temperature. Emissivity of thermocouple is 0.5.

8. Write short notes on the following:
   - a) Lambert's cosine law of radiation.
   - b) Radiation from gases and vapours.
   - c) Heat transfer from cylinder fins of a moving motorcycle.

MODEL QUESTION PAPER-Mechanical Engineering
M.E. (HEAT TRANSFER IN ENERGY SYSTEMS)-I SEMESTER

MD 105 ADVANCED OPTIMIZATION TECHNIQUES (Model paper)
(Four Semester-Credit System-w.e.f. 2007--2008)

Time : 3 Hrs. Max. Marks : 70

Answer any FIVE questions.
All questions carry equal marks.

1. a) What is arithmetic – geometric inequality?
   b) Minimize the following function:
   $$f(X)=\frac{1}{2}x_1^2+x_2+\frac{2}{3}x_1^{-1}x_2^{-1}$$
2. a) Explain the problem of Dimensionality in Dynamic programming.
   b) Maximize $f(x_1,x_2)=50x_1+100x_2$
   Subjected to
   $$10x_1+5x_2\le 2500$$
   $$4x_1+10x_2\le 2000$$
   $$x_1+1.5x_2\le 450$$
   $$x_1\ge 0,\qquad x_2\ge 0$$
3. Solve the following problem using Bala's method.
   Minimize $f=3x_1+2x_2+x_3+x_4$
   Subjected to
   $$x_2x_3+x_4\le 1$$
   $$2x_1+x_2x_3+x_4\ge 3$$
   $$x_i=0\,or1,\ i=1,2,3,4.$$
4. A contractor plans to use four tractors to work on a project in a remote area. The probability of a tractor functioning for a year without a breakdown is known to be 82%. If X denotes the number of tractors operating at the end of a year, determine the probability mass and distribution function of X and also find the expected value and the standard deviation of the number of tractors operating at the end of one year.
5. Find the minimum of
   $$f_1=x_1^2+x_2^2$$
   $$f_2=(x_1-2)^2+x_2^2$$

Subject to

$$x_1 - x_2 - 1 \le 0$$

6. a) Construct the objective function to be used in GAs for a minimization problem with mixed equality and inequality constraints.

   b) Consider the following two strings denoting the vector X_1 and X_2

   X_1: {1 0 0 0 1 0 1 1 0 1}

   X_2: { 0 1 1 1 1 1 0 1 1 0}

   Find the result of crossover at location 2. Also, determine the decimal value of the variable before and after crossover if each string denotes a vector of two variables.

7. a) What is a sigmoid function? How it is affected by weighted sum of inputs, explain.

   b) How is a neuron modeled in neural network-based model, explain with one example.

8. Explain any four of the following.
   a) Goal programming method
   b) Simulated Annealing Algorithm
   c) Continuous Dynamic programming
   d) Branch & Bound method
   e) Complementary Geometric programming

MODEL QUESTION PAPER-Mechanical Engineering
M.E. (HEAT TRANSFER IN ENERGY SYSTEMS)-I SEMESTER

HT-106 MEASUREMENTS IN HEAT TRANSFER
(Four Semester-Credit System-w.e.f. 2007--2008)

Time : 3 Hrs. Max. Marks : 70

Answer any FIVE questions.

1. a) What are the different sources of errors in measuring instruments? (4)

   b) State and explain the Gaussion error distribution law. (6)

   c) From the data given below, obtain '*y*' as a linear function of '*x*' using method of least squares. (4)

y :	1.2	2.0	2.4	3.5	3.5
x :	1.0	1.6	3.4	4.0	5.3

2. a) Explain the construction and working principle of a Linear Voltage Differential Transformer. (6)

   b) Describe the working principle of a photovoltaic cell. Why it is very useful for space applications? (4)

   c) Describe the working principle of Hall-effect transducers with their applications. (4)

3. a) Describe the ionization gage. How does it differ from the pirani gage? List out their advantages and disadvantages. (7)

   b) Explain how calibration of pressure measuring equipment is carried out by using Dead Weight Tester. What are the factors affecting the accuracy of Dead Weight Tester? (7)

4. a) Why is Rota meter called as the drag meter? Could it also be called as an area meter? Sketch and explain its working and derive an expression for the volume flow rate. (6)

   b) i) Describe the working of a Laser Doppler Anemometer. (4)

   ii) A venturi tube of throat diameter 50 mm has a discharge coefficient of 0.98 and with a flow rate of 1 m^3/s, the pressure differential is 12.5 N/m^2. Determine the flow rate when an orifice of 50 mm is used in the same pipe. The discharge coefficient of the orifice is 0.6 and the pressure differential is the same. (4)

5. a) i) In general, why does heat transfer influence the accuracy of a temperature measurement? (4)

ii) A bimetallic thermometer is made up of strips of a nickel-chromium alloy and invar bounded together at 25ºC. Each strip has a thickness of 1 mm and a length of 50 mm. Calculate the radius of curvature produced when the strip is unstrained and is subjected to a temperature of 200ºC. For nickel chrome alloy and invar the moduli of elasticity and coefficients of expansion respectively are: 216 $GN.m^2$, 147 GN/m^2 and 12.5×10^{-6}/ºC, 1.7×10^{-6}/ºC. (4)

b) Describe the construction and working of a Disappearing Filament Optical Pyrometer. List their advantages and disadvantages. (6)

6. a) Describe the working principle of a Gardon foil-type heat flux meter. (4)

b) With neat sketch, describe the method used for measurement of thermal conductivity of solid metals. (6)

c) Discuss the working principle of a Loschmidt apparatus for measurement of diffusion coefficient in gases. (4)

7. a) With a neat sketch, describe any method for measurement of total emissivity of a substance. (8)

b) Explain how nuclear radiation can be detected by using following methods.

i) Photo detectors. (3)

ii) Scintillation counters. (3)

8. Write short notes on the following:

a) Characteristics of manometric liquids. (4)

b) Measurement of temperature in high speed flow. (5)

c) Flow visualization methods. (5)

SECOND SEMESTER

HT 201 THERMAL ENVIRONMENTAL CONTROL

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Introduction: Thermodynamic consideration, Heat transfer considerations: Refrigeration. Vapour compression cycles, Refrigerants, Absorption refrigeration; Psychromatrices: Thermodynamic properties of moist air; Psychrometric charts, Cooling towers and evaporators - Condensers - Cooling and Dehumidifying coils, Air conditioning calculations.

References:

1. Thermal Environmental Engineering by Threkled, J.L.
2. Refrigeration and Air conditioning by Stoker, W.F.

HT 202 CONVECTION HEAT TRANSFER

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Derivation of equations of conservation of mass, momentum and energy, boundary layer approximations, similarity solutions for laminar boundary layer over flat plate, integral methods, forced convection in turbulent flows, eddy diffusivity, momentum and energy equation in turbulent shear layer, analogy between momentum and heat transfer, liquid metal heat transfer, natural convection from a vertical plate and cylinders, free convection in enclosed spaces, combined free and forced convection, heat transfer in MHD systems, transpiration cooling

References:

1. Analysis of heat and mass transfer by E.R.G. Eckert and Robert M. Drake, McGraw Hill
2. Boundary layer theory by Schlichting
3. Heat transfer by Gebhart
4. Natural convection heat and mass transfer by Y. Jaluria , Pergamon press
5. Convective heat and mass transfer by Kays, W.M., and Crawford, M.E., McGraw Hill

HT 203 PRINCIPLES OF ENERGY CONVERSION

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Energy and development; energy demand and availability; energy crisis; conventional and non-conventional, renewable and non-renewable energy resources; environmental impact of conventional energy usage; basic concepts of heat and fluid flow useful for energy systems. Solar energy systems: solar radiation data; solar energy collection, storage and utilization; solar water heating; air heating; power generation; refrigeration and air-conditioning; solar energy system economics. Principles and applications of wave energy, tidal energy, bio-mass energy, concepts of integration of conventional and non-conventional energy resources and systems; integrated energy system design and economics.

References:

1. Energy and environment by Fowler, McGraw Hill
2. Energy by Doolittle, Matrix publishers
3. Introduction to wind energy technology by Lysen, Georgia Inst.
4. Energy, the bio-mass option by John Wiley
5. Solar engineering and thermal process by Duffie and Beckman, John Wiley
6. Principles of energy conversion by A.W. Culp, McGraw Hill

HT 204 DESIGN OF THERMAL EQUIPMENT

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Classification of heat exchangers; basic design methods for heat exchangers, double pipe heat exchangers, parallel and counter flow, design of shell and tube heat exchangers; TEMA codes; flow arrangements for increased heat recovery; condensation of single vapors, mixed vapors; design considerations for different plate type heat exchangers; regenerators, steam generators, condensers, radiators for space power plant, cooling towers, power plant heat exchangers, furnace calculations.

References:

1. Process heat transfer by Donald Kern
2. Heat exchanger design by Press and N. Ozisik
3. Standards of the Tubular Exchange Manufacturers Association, TMEA, New York
4. Heat Exchangers by Kakac, S., A.E. Bergles and F. Mayinger (Eds.) Hemisphere, 1981
5. Compact Heat exchangers by Kays, W.M., and A.L. London, McGraw Hill

HT 205 BOILING AND TWO PHASE FLOW HEAT TRANSFER

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Definitions: 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
Separated flow: Slip; Detailed discussion on bubbly, slug and annular flow; Lockhart-Martinelli method foe pressure drop calculation; pressure drop for flow with boiling; flow with phase change.
Drift flow model: General theory; gravity flows with no wall shear; correlation to simple theory; Armond or Bankoff flow parameters.
Boiling: Regimes of boiling; nucleation; growth of bubbles; bubble motion at a heating surface; heat transfer rates in pool boiling; Rohsenow correlation for nucleate boiling. Zuber's theory for critical heat flux. Bromley theory for film boiling; forced convection boiling; Chen's correlation for flow boiling; maximum heat flux or burn out.

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

References:

1. One-dimensional two-phase flow by Wallis, McGraw-Hill
2. Two-phase flow and heat transfer by Butterworth and Hewitt, Oxford
3. Convective boiling and condensation by J.G. Collier, McGraw-Hill
4. Boiling heat transfer and two phase flow by L.S. Tong, John Wiley
5. Hand book of heat transfer by Rohsenow et al.
6. Transport processes in boiling and two-phase flow systems by Hsu and Graham, McGraw- Hill
7. Heat transfer by J.P. Holman.

Elective – II-HT 206 ENERGY CONSERVATION AND RECOVERY SYSTEMS

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Basic principles of energy conservation - Energy analysis and application of laws of thermodynamics - Energy consumption and rejection patterns for different thermal processes such as air-conditioning, drying, thermal power generation, boilers, furnaces etc., - Energy conservation potential in different thermal processes - Types and applications of different energy recovery equipment's such as run-around coils, regenerators, recuperators, economizers, heat pipe heat exchangers, plate heat exchangers, heat pumps, steam accumulators, storage boilers, waste heat boilers, etc., - Sensible heat, latent heat and thermo-chemical energy storage systems - Thermal insulation and its role in energy conservation - Cogeneration - Case studies.

References:

1. Handbook of Industrial Energy Conservation by S.David hu, Van Nostrand Reinhold Publ., 1983.
2. Handbook of Energy Engineering by D.Paul Mehta and Albert Thumann, The Fairmont Press Inc., 1989.
3. Design and Management for Energy Conservation by P.W.O'Callaghan, Rergamon Press, 1981.
4. Heat Pumps by K.Brodowicz and T. Dyakowski, Buttormorth-Heinemann Press., 1993.

Elective – II-HT 206 ADVANCED FINITE ELEMENT ANALYSIS

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

Introduction, Finite elements of an elastic continuum - displacement approach, generalization of the finite element concept - weighted residuals and variational approaches. Plane stress and plane strain, Axisymmetric stress analysis, 3-D stress analysis.

Element shape functions - Some general families of C continuity, curved, isoparametric elements and numerical integration. Some applications of isoparametric elements in two-and-three dimensional stress analysis.

Bending of thin plates - A C continuity problem. Non-conforming elements, substitute shape functions, reduced integration and similar useful tricks. Lagrangian constraints in energy principles of elasticity, complete field and interface variables (Hybrid method).
Shells as an assembly of elements, axisymmetric shells, semi-analytical finite element processes - Use of orthogonal functions, shells as a special case of 3-D analysis. Steady-state field problems - Heat conduction, electric and magnetic potentials, field flow.
The time domain, semi-descritization of field and dynamic problems and analytical solution procedures. Finite element approximation to initial value - Transient problems.

References:

1. The Finite Element Method by Zienkiewicz, O.C.
2. The Finite Element Methods in Engineering by Rao, S.S.
3. Concepts and Applications of Finite Element Analysis by Cook, R.D.
4. Applied Finite Element Analysis by Segerland, L.J.

Elective – II-(C) HT 206 COMPUTATIONAL FLUID DYNAMICS

((Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 4 Th. Ses. : 30 Exam: 70
Examination (Theory): 3hrs. Credits: 4

HT 207 SEMINAR

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Periods/week: 3Pr Ses. : 50
Credits : 2

The student has to give at least three seminars on topics related to Heat Transfer and Energy systems.

THIRD SEMESTER

HT 301 PROJECT

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Project (to be continued in Fourth semester)

Periods per week: 12 Credits: 14

Semester end appraisal of Project Through seminar by a committee consisting of Head of the Department, Chairman, Board of Studies & Guide

FOURTH SEMESTER

(Four-Semester Course -Credit System- w.e.f. 2007-2008)

Project (continued from Third semester)

Periods per week: 12

Presentation followed by Viva-Voce Examination with the following members.

1. Chairman, Board of Studies.
2. Head of the Department.
3. External Examiner.
4. Internal Guide and External Guide (if any).

No marks are allotted for the Project work.
Viva-voce - Examination: Recommended/Not recommended.
For final result the dissertation credits are not added for CGPA..