College of Engineering, Pune

END SEMESTER EXAM: November 2011

Year (F.Y. M.Tech - Mechanical-Heat Power Engineering)

(ME 5202) ADVANCED HEAT TRABSFER

Day and Date: Sunday, November 27, 2011 — Max. Marks: **50**

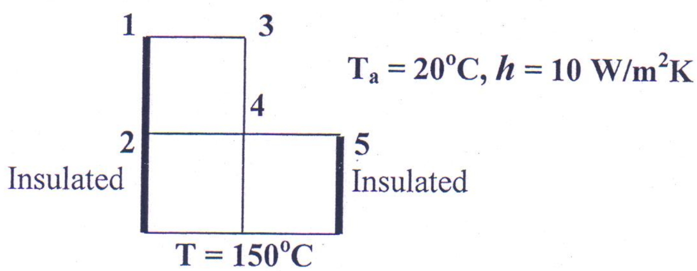
Duration: **Three Hours**

Instructions:

1) *Answer any **FIVE** questions.*
2) *Neat diagrams must be drawn **wherever** necessary.*
3) *Figures to the **right** indicate **full** marks.*

Q.1 a) Derive the relation for temperature distribution and rate of heat loss from a circular pin fin with its tip insulated. [5]

b) Consider the Figure. Using Numerical Method determine the Temperature Distribution for nodes 1 to 5: Left and right surfaces are insulated. Bottom surface is maintained at 150°C and top surface is subjected to convective heat transfer to atmosphere at 20°C. [5]



$\Delta x = \Delta y = 1$ cm, $k = 20$ W/m.K

Q.2 a) State the assumptions and derive the equations for mass flow rate, δ, h_x, and h_{ave}; for laminar film condensation on a vertical plate. [5]

b) A hollow conductor with $\mathbf{r_i = 0.6}$ **cm** and $\mathbf{r_o = 0.8}$ **cm** is made up of metal of **k** = **20 W/m.K** and electrical resistance per meter of **0.03 ohms**. Find the maximum allowable current if the temperature is not to exceed **50°C** anywhere in the conductor. The inside surface of conductor is at **38°C**. The conductor is insulated from outside. [5]

Q.3 a) Derive expression for **effectiveness** by **NTU method** for counter flow heat exchanger and reduce it for two special cases. [5]

b) Consider two large parallel plates, one at **1000 K** with emissivity **0.8** and other at **300 K** having emissivity **0.6**. A radiation shield is placed between them. The shield has emissivity as **0.1** on the side facing hot plate and **0.3** on the side facing cold plate. Calculate percentage reduction in radiation het transfer as a result of radiation shield and the temperature of the shield. [5]

P.T.O.

Q.4 a) For fully developed steady laminar flow in circular pipe with parabolic velocity profile $\mathbf{u = U_{max} [1 - (r/R)^2]}$ and constant surface heat flux, show that the Nusselt number for this situation is **4.364** [6]

b) A vertical square plate, 0.3 by 0.3 m, is exposed to steam at atmospheric pressure. The plate temperature is 98°C. Calculate the Average Reynolds number, heat transfer, and the mass of steam condensed per hour. Take: ρ_l = **960 kg/m³**; k_l = **0.68 W/m.K**; μ_l = **2.82 x 10^{-4} kg/m.s**; h_{fg} = **2255 kJ/kg.K.** [4]

Q.5 a) State Plank's law and from that derive Wein's law, Reyleigh-Jean's law and Wein's Displacement law, value of Stefan Boltzmann Constant and relation for $(Eb_\lambda)_{max}$. [6]

b) **16.5 kg/s** of the product at **650°C** (C_p = **3.55 kJ/kg.K**), in a chemical plant, are to be used to heat **20.5 kg/s** of the incoming fluid from **100°C** (C_p = **4.2 kJ/kg.K**). If the overall heat transfer coefficient is **0.95 kW/m².K** and installed heat transfer surface is **44 m²**, Calculate the fluid outlet temperatures for the counter-flow and parallel flow arrangements. [4]

Q.6 a) Explain Hottel's crossed string method for estimating shape factor for infinitely long surfaces. Derive the expression for $\mathbf{F_{12}}$ in terms of areas and lengths of surfaces. [4]

b) Air at **20°C** flows over a thin plate with a velocity **of 3 m/s.** The plate is 2 m long and 1 m wide. Estimate the boundary layer thickness at the training edge of the plate and the total drag force experienced by the plate. Also calculate the mass flow of air which enters which enters the boundary layer between x = 30 cm and x = 80 cm. [6]

Properties of air are: $\rho = 1.17\ kg/m^3;\ \upsilon = 15 \times 10^{-6}\ m^2/s.$

Take velocity profile $u = U[1.5\,(y/\delta) - 0.5\,(y/\delta)^3]$

Q.7 Write Short Notes on **Any Four** of the following: [10]

(i) Forced Boiling,
(ii) Gas Radiations,
(iii) Boundary Layer, Displacement, Momentum and Energy Thickness,
(iv) Electrical Analogy in Radiation Heat Transfer,
(v) Critical and Economic Thickness of Insulation,
(vi) Ablation Heat Transfer.

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College of Engineering Pune
End Semester Examination
F.Y. M.Tech. (Mechanical Engg.)

ME 5103: Computer Aided Design

[Time: 3 Hours] [Max. Marks: 50]

Instructions:

1. Answer all the questions.
2. Figures to the right indicate full marks
3. Assume suitable data, if required.

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1. (a)

A square is located as one of its vertices coincides with the origin of X-Y coordinate frame and an edge making an angle of +30 degrees from X axis. The length of the edges of the square is 10 units. Calculate the new position of the square, if it is rotated by any angle -30 degrees. 07

(b)

How homogeneous coordinates are helpful in transforming the origin. Explain.03

2. The control points of an open third order B-spline curve are given by $r_0 = [0\ 0]$, $r_1 = [5\ 0]$, $r_2 = [10\ 10]$, $r_3 = [6\ 4]$, $r_4 = [0\ 0]$. Sketch the approximate shape of the curve giving the coordinates for u = 0, 0.25, 0.5, 0.75, 1. Use standard formulae for calculating the basis functions. 10

3. It is desired to develop bounded primitives for a two-dimensional solid modeler based on CSG scheme. A plate (rectangular plate and triplate) and disc primitives are to be developed. Find the mathematical definitions of these primitives. 10

4. Apply the steps of the FEA procedure to find out the displacement of a cantilever beam at the free end. The beam is fixed at one end and loaded with a load F at the other end. Assume suitable data required to explain the procedure. 10

5. Write short notes on any two of the following: 10

(i) Database Coordinate Systems
(ii) Characteristics of a good representation scheme for solid modeling
(iii) Solid manipulations
(iv) Requirements of meshing and mesh generation methods

COLLEGE OF ENGINEERING, PUNE-5
END SEMESTER EXAMINATION
(5201) Fluid Dynamics

Programme: F. Y. M Tech (Thermal Engg.) **Branch: Mechanical Engineering**
Duration: 3.00 Hrs Year: 2011-12 **Max Marks: 50**

Instructions: 1) Answer any Five questions
2) Neat diagrams must be drawn wherever possible
3) Assume suitable data, if necessary
4) Use of logarithmic tables, heat and mass transfer data book, non programmable electronic calculators and steam tables are allowed.

Q 1. a) Differentiate between Lagrangian and Eulerian Approaches of description of fluid motion. [03]

b) The velocity field in an incompressible fluid medium is given by $\vec{V}$ = -x **i** + 2y **j** + (5-z) **k**. Determine the equation of stream line through (2,2,1). [03]

c) The velocity potential function for a flow is given by $\phi = x^2 - y^2$. Verify that the flow is incompressible and determine the stream function for the flow. [04]

Q 2. a) Draw the two dimensional plane flows such as uniform flow, source flow, sink flow and write down the equations of stream function and velocity potential for these flows. [06]

b) An incompressible flow around a circular cylinder of radius *a*, is represented by the stream function [04]
$\psi = -U r \sin\theta + (U a^2 \sin\theta)/r$ where, U represents the free stream velocity. Show that V_r (the radial component of velocity) = 0 along the circle, r = *a*. Find the values of θ at r = *a*, where |**V**| = U.

Q 3. a) A gas filled piston cylinder arrangement. At one instant when the piston is L = 0.15 m away from the closed end of the cylinder, the gas density is uniform at density is 18 kg/m^3 and piston begins to move away from the closed end at V = 12 m/s. The gas motion is one dimensional and proportional to distance from the closed end; it varies linearly from zero at the end to u = V at the piston. Evaluate the rate of change of gas density at this instant. Obtain an expression for the average density as a function of time. [06]

b) Define plain circular free vortex and force vortex flow and give the expression for velocity field and pressure distribution of these flows. [04]

Q 4. a) Derive the Prandtl laminar boundary layer equation. [04]

b) A liquid flow down an inclined plane surface in a steady fully developed laminar film of thickness h. Simplify the continuity and Navier-Stokes equations to model this flow field. Obtain expression for the liquid velocity profile, the shear stress distribution, the volume flow rate, and the average velocity. Relate the liquid film thickness to the volume flow rate per unit depth of surface normal to the flow. Calculate the volume flow rate in a film of water 1 mm thick flowing on a surface 1 m wide, inclined 15° to the horizontal. [06]

Q 5. a) Define the following terms [04]

i) Fanno Line Flow

ii) Displacement Thickness

iii) Rayleigh Line

iv) Boundary Layer Thickness

b) A smooth flat plate 1.5 m long, 30 cm wide is placed in a stream of air at 8 m/s. Calculate: i) thickness of boundary layer ii) displacement thickness iii) momentum thickness at the edge of the plate; Assume laminar flow and a third degree velocity profile in the boundary layer. For air, $\rho = 1.2\ kg/m^3$, $\nu = 15 \times 10^{-6}\ m^2/s$. [06]

Q 6. a) Explain the effect of back pressure in convergent divergent nozzle. [05]

b) Air flows steadily and isentropically in a converging-diverging nozzle. At the inlet 350 kPa (abs), 60 °C and 183 m/s to Ma = 1.3 outlet, where local stagnation conditions are 385 kPa (abs) and 350 K. Compute the local stagnation conditions at the inlet of nozzle and static outlet conditions nozzle. [05]

COLLEGE OF ENGINEERING

(Formerly Government College of Engineering, Pune)

END-SEM EXAM

Semester I: 2011-2012

(ME 5201) Advance Thermodynamics

Year: F. Y. M. Tech
Semester I

Year: 2011-12

Duration: 3 hrs

Branch: Mechanical Engineering
Specialization: Heat Power Engineering

Date: 23/11/2011

Max. Marks: 50

Instructions:

1. Attempt any **FOUR** questions.
2. Figures to the right indicate full marks.
3. Make necessary assumptions and assume suitable data wherever required.
4. Use of non-programmable calculators, steam tables and gas tables are allowed.

Marks

Q1. a) `Discuss FERMI-DIRAC distribution law and show that:

$$\frac{\overline{N}_i}{g_i} = \frac{1}{\exp(\frac{\varepsilon_i - \mu}{k_B T}] + 1}$$ **5**

b) An ideal gas mixture contains 0.25 kg of CO, 0.69 kg of CO_2 and 0.16 kg of O_2 at 1.5 bars and 20^0C. Compute i) the volumetric analysis, ii) the apparent gas constant, in kJ/(kg-K), iii) apparent molar mass iv) the volume occupied by the mixture, in cubic meters and v) the partial pressure of CO, CO_2, and O_2 in kPa. **5**

c) Ethane gas is maintained at 2.3 MPa and -43°C. Compute the specific volume in m^3/kg, on the mass basis of i) the ideal-gas equation, ii) the van der Waals equation, iii) the Redlich-Kwong equation. **3**

Q2. a) Ethylene (C_2H_4) at 25^0 C is burned with excess air which enters the steady-flow combustor at 500 K. If the final temperature of the gas phase, reaction is 1800 K, determine the percentage of excess air used under adiabatic conditions **5**

b) The equilibrium constant K_p for the gas-phase reaction $CO + \frac{1}{2} O_2 \rightleftarrows CO_2$ is found to be 3.055 at 3000 K Estimate the value at 1800 K, based on the van't Hoff isobar equation **5**

c) Clarify the concept of IInd Law efficiency with the help of a suitable practical example. **3**

Q3. a) Water enters a heat exchanger at a rate of 50 kg/s as compressed liquid at 0.20 MPa & 90^0 C and leaves at the same pressure and 120^0 C. The heat is supplied to the water stream from a stream of hot air which enters at 680 K and 0.30 MPa and leaves at 460 K at the same pressure. Determine i) the change in the stream availability of the water, ii) the change in the stream availability of the air, and iii) the overall irreversibility of the heat-exchange process, all answers in kJ/s. The environmental temperature is 290 K. **4**

b) For the dissociation of SO_3 according to the equation $SO_3 = SO_2 + ½\ O_2$, the equilibrium constant is given by the approximate relation $K_p = -\ 11400/T + 10.75$, where T is in kelvins. (i) Estimate the enthalpy of reaction, kJ/kgmol, (ii) If 0.01 mol of SO_3 is sealed in a rigid but un-insulated vessel at 1 atm and 300 K, determine the temperature to which the system must be heated to permit 5% of the SO_3 to dissociate, and iii) For the final conditions of 'part (ii)', determine the final vessel pressure, in atmospheres. **4**

c) Determine the adiabatic-combustion temperature, in kelvins, and the explosion pressure, in $M_{pa,}$ for the constant-volume combustion of liquid Ethyl alcohol with 60% excess air. Initial conditions are 0.1 bar and 27^0 C. **4**

Q. 4 a) i) Construct a diagram having eight energy levels. Show the possible microstates of the system if the energy U = 7ε for six indistinguishable particles, obeying B-E statistics.
ii) Calculate the thermodynamic probability of each macrostate,
iii) Show that the total microstates Ω is 2340 and **5**
iv) Find the average occupation number of each level.

b) Distinguish between i) MAXWELL-BOLTZMANN ii) BOSE-EINSTEIN and iii) FERMI-DIRAC statistics **5**

c) What is the importance of Clausius-Clapeyron latent heat equation? Derive this equation and outline its applications. **3**

Q.5 Write short notes on (Any three): **12**

i. Statistical interpretation of II^nd Law.
ii. 'The Law of Corresponding States'
iii. Fermi–Dirac Statistics.
iv. Maxwell Demon theory.
v. Generalized enthalpy departure chart

ME 5312

PIET'S COLLEGE OF ENGINEERING, PUNE-5

END SEMISTER EXAMINATION

M-Tech (Automobile Engineering)

COMPUTATIONAL MODELING AND SIMULATION

Marks – 50

Duration – 3.0 Hrs

Instructions –

1. Make suitable assumptions wherever necessary.
2. All questions are compulsory.

Que. 1 –

(a) Differentiate between differential and integral approach of obtaining the solution to fluid flow and heat transfer problems. (3)

(b) Using constitutive relationship for Newtonian, homogeneous and isotropic fluid, prove that the strain rates can be obtained in terms of velocities i. e. prove that $\dot{\varepsilon} = \partial u / \partial x$ **and** $\partial v / \partial y$. (8)

Que. 2

(a) Figure 1 indicates the discretized representation of domain for heat conduction in a plate. Obtain the discretized boundary conditions for the boundary control volume cell centres along all the boundaries.

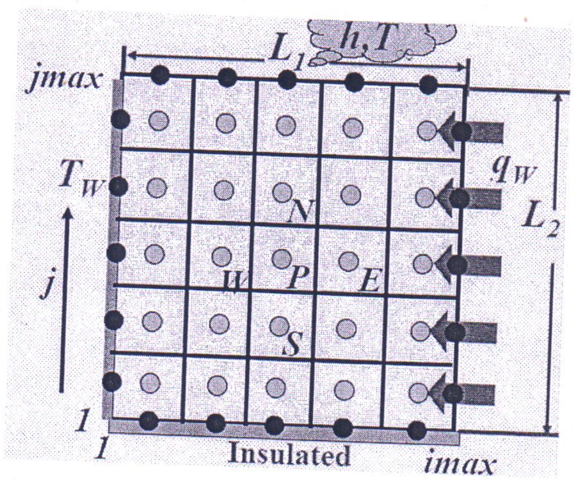


Figure 1

(8)

(b) Write down the finite volume discretization of convection and diffusion terms of momentum and energy equations along with two levels of approximations used in the discretization. Discuss the physical interpretation of different fluxes encountered during discretization. (8)

Que. 3

(a) Consider 2-D unsteady state convection diffusion energy equation with a prescribed velocity field i.e. $u < 0$ and $v > 0$. For explicit finite volume discretization method with uniform grid size $\Delta x = \Delta y$, determine the coefficient of the linear algebraic expression $a_P T_P^{n+1} = a_E T_E^n + a_W T_W^n + a_N T_N^n + a_S T_S^n + b$ for a representative interior cell using FOU scheme for the convection term and central difference discretization for the diffusion term. Present your resu[lt in] the tabular form in terms of D, C_1 and C_2 where $D=\alpha\Delta t/\Delta x^2$; $C_1= u\,\Delta t/\Delta x$ and $C_2 = v\,\Delta t/\Delta x$.

Velocity direction	a_E	a_W	a_N	a_S	a_P	b
$u < 0$ and $v > 0$						

(8)

(b) Draw u, v, and P control volumes with all grid points of velocity and pressure on these control volumes.

(3)

Que. 4

(a) Derive pressure correction equation from the continuity equation.

(4)

(b) Consider the lid-driven cavity problem with lid moving at a non dimensional velocity of 1. Write down the discretized boundary conditions for velocities. Write down the SIMPLE algorithm for the solution of the entire Navier-Stokes equation for such a problem. Explain the important steps in the solution methodology.

(8)

COLLEGE OF ENGINEERING, PUNE

F.Y. M.TECH (MECH)

END-SEMESTER EXAMINATION 2011-12

Sub: Advanced Refrigeration and Cryogenics

Time: 3hrs Max. Marks: 50

INSTRUCTIONS: **1. All questions carry equal marks**
2. Make suitable assumptions and state them clearly
3. Use of calculator is allowed
4. Use of refrigerant properties and charts allowed

1 (a) Give limitations of single-stage v-c refrigeration cycle. (5)

OR

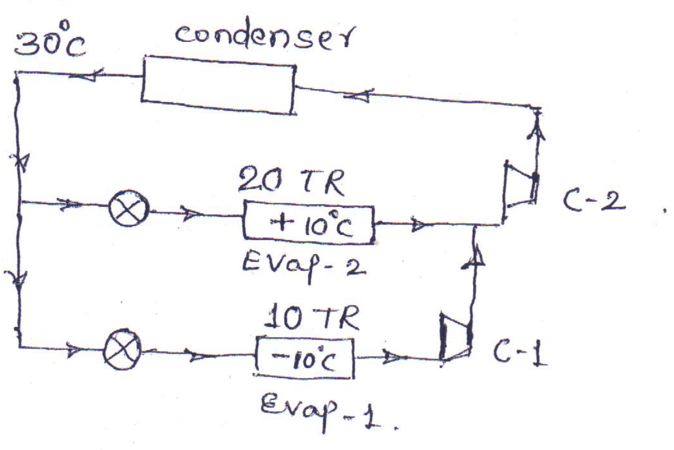
Draw a neat sketch of a split Ac of 2TR capacity. Write its technical specifications. What is the primary and secondary heat transfer area in m^2 of the condenser of such AC unit

b) A typical multi-evaporator system is given below. The refrigerant used is R-12. Sketch the cycle on p-h diagram. Make use of p-h chart, there is no suction gas superheating and subcooling. Calculate (5)

i) Mass flow rate of refrigerant through each compressor

ii) The load on condenser

iii) Over all COP of the system



2. Write short note on *any four* of the following 10

i) A refrigeration system to produce cold at -80°C.

ii) Types of Evaporators

iii) Installation procedure of refrigeration system

iv) Aqua-ammonia absorption system

v) Thermostatic expansion valve

vi) Surging Phenomena

3. a) Draw a hermetic reciprocating compressor showing the internal details. Explain the calorimetric testing procedure of such a compressor stating the various parameters to be controlled during the test. (5)

b) What is meant by capacity control of the reciprocating compressor? What are the methods to control capacity of such compressors? Explain with suitable diagrams. (5)

4 A domestic refrigerator has the outside dimensions of 50cmX50cmX100cm. It has a PUF Insulation of thickness 50cm and a supporting GI sheet of 1mm on both sides of each and every wall and also for the door. (10)

There are such two identical refrigerators one having fitted with the condenser unit inside the walls, while in second refrigerator it is placed outside the refrigerator.

Calculate the rate of heat flow in both the cases. Can you make comments regarding the energy efficiency of the said units? You can make suitable assumptions if required.

5 (a) Give applications of cryogens. Draw the block diagram, T-s diagram of a thermodynamically ideal cycle of air liquefaction system (5)

(b) Give limitations of of Linde-Hampson liquefaction system. Explain Claude System with the help of T-s and block diagrams. (5)

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