ME (Thermal. Eng), Sem - II, A.T.K.T 17/12/14

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to University of Mumbai)

KT EXAMINATION, DECEMBER 2014

Total Marks: 100 Duration: 4 Hours

ME(THERMAL ENGG.) SEM – II **COMPUTATIONAL FLUID DYNAMICS**

- Attempt any **FIVE** questions out of seven questions.
- Answers to all sub questions should be grouped together.
- Figures to the right indicate full marks.
- Make suitable assumption with proper explanation.

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1. a) What do you understand by numerical simulation? Discuss its limitations and with suitable examples, explain its potential in carrying out research work and design activities. 10

   b) $4t_1 + 2t_2 + 3t_3 = 17$
   $2t_1 + 3t_2 + 4t_3 = 20$
   $t_1 + 4t_2 + 2t_3 = 170$ 10
   Suggest any 2 methods of each direct and iterative type to obtain the value of variables.
   Compare the resulting solution with Jordon method with 6 iterations. Explain if any unrealistic development in the iterative solution is observed.

2. a) Explain turbulence and its characteristics. Discuss important postulates of Reynolds to modify Navier-Stokes equation for turbulence. 10

   b) Classify second order partial differential equation based on nature of the solution. With suitable example explain each one. Write Poission's equation and state its type with supporting explanation. 10

3. a) Why turbulence model is need to solve turbulent flow problem? Derive Prandtl's mixing length model. 10

   (b) Develop governing equation for a 1D convection-diffusion heat transfer with known velocity field using generalized energy equation. Discretize the equation using FVM approach and discuss its stability restrictions arising due central difference interpolation of convective term. 10
   Suggest two methods to avoid convergence and stability restrictions.

4. (a) Name conservation equation to solve heat and flow problems. Derive momentum equation by using control volume approach. 10

   (b) Develop pressure correction equation and discuss the implementation procedure of SIMPLE algorithm. 10

5. a) What is transient problem? Explain Crank-Nicolson differencing to solve problems 10

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governed by parabolic equations.

b) A plate of copper with k = 401W/mK and density=8933 kg/m^3; Cp=385 J/kgK is initially at 298 K and is exposed to 350 K suddenly. Calculate temperature profile assuming 1D variation using explicit and implicit schemes and compare. **10**

6. a) Discuss common methods of domain discretization. Differentiate among them with their merits and demerits. **10**
Why boundary conditions are needed? List common thermal and flow boundary conditions used in CFD.

b) Consider conductive heat transfer through a wall with heat generation under steady state. Face A and B are maintained at constant temperatures. **10**
Data: Wall thickness L = 2cm,
Constant thermal conductivity k = 5 W/m^2.K,
$T_A = T_B$=100°C,
Volumetric heat generation q = 500 Kw/m^3.
(a) Develop governing equation and write appropriate boundary condition.
(b) Discretize the computational domain in 5 equal parts and write nodal equation using FVM.
(c) Solve the discretized equations using TDMA.
(d) Solve the discretized equations by using Gauss Siedel Method / Jordon Method showing 5 steps of iteration.

7. The rectangular plate copper plate with (k = 350 W/mK) has dimensions 20cm by 30cm and is 1cm thick. Boundary conditions are: **20**

Left:400°C, Right: h = 25 W/m^{2}K T_∞=23°C
Top: Insulated, Bottom: heat flux =3 kW/m^2

Neglecting the heat flow in the direction normal to the plane assuming steady state condition,
(i) Develop a mathematical model in differential form.
(ii) Assuming 4 horizontal and 6 vertical meshes develop nodal equations.
Use line by line method solution for one horizontal and one vertical sweep.

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SARDAR PATEL COLLEGE OF ENGINEERING
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KT - END SEM-EXAMINATION, DEC 2014

SEM / CLASS: SEM II / M. E. (THERMAL ENGG.) **TOTAL MARKS: 100**
SUBJECT: DESIGN OF HEAT EXCHANGER **TIME: 04 HRS**

Master
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- Use of HMT Data Book and DATA Book Xerox are allowed.
- Attempt **any Five questions** out of seven questions.
- Answers to all sub questions should be grouped together.
- All questions carry equal marks.
- Make suitable assumptions with proper explanations.

Q.1. Answer the following questions (**Any Five**)

a.	Why are the baffles used in shell and tube heat exchanger?	**04**
b.	What is fin efficiency? What does it depend upon?	**02 + 02**
c.	What are the main selection criteria of a heat exchanger?	**04**
d.	What are the advantages and the limitations of gasketed plate heat exchangers?	**02 + 02**
e.	What is tube pitch? What factors decide the pitch in a particular case?	**02 + 02**
f.	State the different types of fouling.	**04**

Q.2. **Design a Gasketed-plate heat exchanger**: **10 + 10**

The details of the heat exchanger are:

1. **Constructional Information**:

Chevron angle (β) = 50°, enlargement factor (ϕ) = 1.17, all port diameter (D_p) = 15 cm, plate thickness (t) = 0.006 m, vertical port distance (L_v) = 1.5 m, horizontal port distance (L_h) = 0.5 m, plate pitch (p) = 0.0035 m, plate material titanium (k = 20 W/m./k),

2. **Process Specification**:

This heat exchanger will be used for heating city water ($R_{fc} = 0.00006\ m^2.K/W$) using the waste water ($R_{fc} = 0.00006\ m^2.K/W$) available at 90°C. The cold water enters the heat exchanger at 15°C and leaves at 45°C at a rate of 6 kg/s and it will be heated by the hot water available at 90°C, flowing at a rate of 12 kg/s and outlet temperature of hot water is 70°C.

3. **Other Data**:

Maximum permissible pressure drop for both fluids = 50 psi, consider single pass arrangement for both fluids, overall heat transfer coefficient = 5000 $W/m^2\ K$, Assume other suitable required data with proper explanation.

Assume the following data for both fluids:

Specific heat = 4183 J/kg.K, viscosity = 6 x 10^{-4} N.s/ m^2 , thermal conductivity = 0.635 W/m.K, density = 990 kg/m^3, Pr. No. = 4

Use correlation as:

$Nu = \frac{hD_h}{k} = 0.3\ (Re)^{0.663}\ (Pr)^{0.333}\ [\mu]^{0.17}$

Take friction coefficient for hot and cold fluids as $f = (1.441)/(Re)^{0.206}$

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List the results in the Table and compare the results and explain your conclusions.

Calculate :

1. The effective surface area and the number of plates of this heat exchanger
2. The pressure drop for both streams.

Q.3. **Design a single shell and a single tube pass shell and tube heat exchanger.** **20**

Raw water will be heated by the use of condensed water at 67°C and 0.2 bar, which will flow in the shell side with a mass flow rate of 50000 kg/hr. The city water will be coming from a supply at 20°C with a mass flow rate of 30000 kg/hr. The specific heat of city water is 4180 J/kg.K.

Consider the following data:

Fouling resistance = $0.00006\ m^2.K/W$, surface over design should not be over 40%, consider maximum coolant velocity of 1.8 m/s to prevent erosion. Because of space limitation, maximum tube length may be 5m, tube material (Carbon Steel) thermal conductivity = 60 W/m.K. Raw water will flow inside of straight tubes of 19 mm OD with 16 mm ID. Consider square pitch tube lay out with pitch ratio of 1.25. Baffle spacing may be considered as 0.6 of shell diameter and baffle cut as 25%. Permissible maximum pressure drop on shell side is 5 psi. Water outlet temperature should not be less than 40°C. Assume shell side and tube side heat transfer coefficient is 5000 W/m^2K.

Calculate: shell diameter, number of tubes, tube length, baffle spacing, baffle cut, pitch size, total pressure drop for both streams for fixed heat duty.

Use properties of fluid at bulk mean temperature:

	Shell side fluid	Shell side fluid
ρ (kg/m^3)	984	997
Cp (J/kg.K)	4184	4179
μ (N.s/m^2)	4.67×10^{-4}	8.2×10^{-4}
K (W/mK)	0.652	0.610
Pr	3	5.65

Use correlation for shell side heat transfer coefficient as:

$$Nu = \frac{h_o D_e}{K} = 0.36\,(Re)^{0.663}\,(Pr)^{0.333}$$

Use correlation for tube side heat transfer coefficient as:

$$Nu = \frac{\frac{f}{2}(Re-1000)\,Pr}{1.07+12.7\sqrt{\frac{f}{2}}\left(Pr^{\frac{2}{3}}-1\right)} \quad \text{and} \quad f = [1.58\ln(Re) - 3.28]^{-2}$$

Use correlation for pressure drops on the shell side and tube side respectively:

$$(\Delta P)s = \frac{f\,Gs^2(N_b+1)D_s}{2\rho\,D_e\,\varphi_s} \quad \text{and} \quad (\Delta P)t = \left[4f\left(\frac{LN_p}{d_i}\right) + 4N_p\right]\left[\frac{\rho u_m^2}{2}\right]$$

Q.4. **A}** Explain the applications of Bell-Delaware Method in design of shell and tube heat exchanger. What are the different streams identified in Bell-Delaware Method of heat exchanger? Explain the considerations of all the streams in the design. **3 +3+4**

B} List the assumptions used in basic design methods of heat exchangers. What are the basic design calculations of heat exchangers? **5+5**

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Q.5.	**A}** Write short notes on Spiral recuperator and Honeywell recuperator.	**04+04**
	B} What are the applications and objective of design of compact heat exchangers? Explain the methods of design of plate-fin and tube-fin compact heat exchanger.	**05+07**
Q.6.	Compare the gasketed plate heat exchangers and double pipe heat exchangers on the basis of weight and space limitations, temperature approach, operating temperature, pressure drop limitations, maintenance requirements, capital and operating costs. Also compare the constructional parameters of both. Draw the necessary diagrams of each heat exchanger.	**20**
Q.7.	**Write short note on the following (any five)**	**20**
a.	Heat transfer in helical coils and spirals	
b.	Heat exchanger design methodology	
c.	LMTD Method for heat exchanger analysis	
d.	Heat exchanger pressure drop and pumping power	
e.	Thermal and hydraulic analysis of double pipe heat exchangers	
f.	Baffle types and geometry of baffles in shell and tube heat exchangers	

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Sardar Patel College of Engineering

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Second Half 2014

Class/ Sem: **M.E. (Thermal Engineering) / II**

Subject: **Piping Engineering**

Duration: 4Hrs.

Total Marks: 100

Note: Attempt any five questions out of seven questions.
Answers to all sub questions should be grouped together.
Figures to the right indicate full marks.
Assume suitable data wherever necessary.
Draw neat sketches wherever required.

MASTER FILE

Q1 **a)** Draw neat functional diagram, explain the working, and write advantages, limitations and applications of butterfly valve. **10**

b) Write a note on fabrication precaution. **05**

c) Find the optimum diameter of pipe for CO_2 at 100 °C, 3 atm. Pressure, 500 kg/hr and 15 m/s velocity. **05**

Q2 **a)** Draw a neat schematic diagram. Write objective, what should be shown & what should not be shown in Piping & Instrumentation Diagram. **10**

b) Explain with neat sketches following types of supports: **10**

1) Welded shoe 2) Hanger 3) Trunion

Q3 **a)** Write notes on the following codes/standards (Any two) **10**

1) IBR 2) Gas Cylinder Rules 3) ASME – ANSI B31.1 & B31.3

b) A water pump has to deliver water from a reservoir at a rate of 200 m^3/hr at 20°C through a new ERW pipe of NB 150mm to an overhead tank at 6m height. The pipe length is supposed to be 70m, with two non-return valves, one gate valve & four 90°formed bends with a radius of 2d. Find the total pressure head at the pump. The pump center is 2m above the water level of the reservoir. **10**

Data:

Coefficient of resistance ζ for NB 150mm pipe size:

Gate Valve=3.6, Non-return Valve=0.8, Bend=0.14.

Friction factor for commercial pipe NB 150mm $\lambda = 0.028$

Q4 **a)** Explain along with examples, different types of forming methods relevant to piping **10**

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engineering.

b) Distinguish between Male and Female type flange and Tongue and Groove type flange with simple sketch. Explain when each of the flange type is useful. 06

c) Draw simple sketch and explain the basic function of the following piping elements. 04

i) 45^0 Elbow and 90^0 Elbow ii) Equal Tee and Reducing Tee

Q5 a) What are the factors affecting piping layout? Explain briefly. 08

b) Write notes on: 12

i) Unit Plot plan. ii) Master plot plan iii) Piping Isometrics

Q6 a) The following data refers to a header & branch pipe connection: 15

Nominal diameter of header pipe (Schedule 40)	= 10"
Outer diameter of header pipe	= 10.75"
Minimum thickness of header pipe	= 0.219"
Nominal diameter of branch pipe (Schedule 20)	= 4"
Outer diameter of branch pipe	= 4.5"
Minimum thickness of branch pipe	= 0.207"
Design pressure	= 400 psig
Design Temperature	= 650°F
Corrosion allowance	= 0.03"
Allowable stress for ASTM A53 Grade B at design temperature (For both Header & Branch pipe)	= 15000 psi
Thickness of reinforcing pad	= 0.25"

Design a suitable reinforcing pad if it is to be made from a plate of equal quality to that of the pipe material. Assume Machining tolerance 12.5% and Y = 0.4.

b) Write note on Stress Intensification Factor & Flexibility Factor. 05

Q7 Write notes on (Any four): 20

i) Role & Scope of piping.

ii) Welders' qualification.

iii) Expansion loops.

iv) Role of computers in piping.

v) Traced piping.