Gb 30/4/13 mech. Master file

M.E (Thermal Engg), Sub - Design of heat Exchanger

30/4/13

BHARATIYA VIDYA BHAVAN'S

SARDAR PATEL COLLEGE OF ENGINEERING

[An Autonomous Institution Affiliated to University of Mumbai]

END SEMISTER EXAMINATION, MAY 2013

SEM / CLASS: SEM II / M. E. (THERMAL ENGG.) **TOTAL MARKS: 100**

SUBJECT: DESIGN OF HEAT EXCHANGER **TIME: 04 HRS**

- Use of Heat and Mass Transfer Data Book is allowed.
- 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 assumptions with proper explanations.

Q. 1: (A) What are the main selection criteria of a heat exchanger? **05**

(B) Compare Gasketed-Plate heat exchanger with Double-Pipe (Hairpin) heat exchanger on the basis of following points: **10**

i) Weight and space limitations ii) temperature approach

iii) Pressure drop limitations iv) capital and operating cost

v) Maintenance requirements

(C) Answer the following questions. **05**

(i) Since fins increase the heat transfer area, why are they not used in all the cases?

(ii) What factors decide the type of the tube header to be chosen?

Q. 2: The objective of this problem is to design an oil cooler with sea water. The decision was made to use a hairpin heat exchanger. **20**

Fluid	Annulus Fluid, Engine oil	Tube-side Fluid, Sea water
Flow rate (in) kg/s	4	---
Inlet temperature, °C	65	20
Outlet temperature, °C	55	30
Density, kg /m^3	885.27	1013.4
Specific heat, kJ/kg.K	1.902	4.004
Viscosity, kg/m.s	0.075	9.64×10^{-4}
Prandtl No. (Pr)	1050	6.29
Thermal conductivity, W/m.k	0.1442	0.6389

Length of hairpin = 3m, Annulus nominal diameter = 2 in, Nominal diameter of inner tube (schedule 40) = ¾ in, Fin height, H = 0.00127m, Fin thickness, δ = 0.9mm, Number of Fins/tubes = 18, Material throughout = carbon steel,

PTO

Thermal conductivity, K = 52 W/m.k, Number of tubes inside annulus = 3, fouling resistances are $R_{f0} = 0.176 \times 10^{-3}$ m^2.K/W (engine oil), $R_{fi} = 0.088 \times 10^{-3}$ m^2.K/W (Sea water)

Take tube outer diameter d_0 = 0.02667m, tube inner diameter di = 0.02093m, Annulus inner diameter Di = 0.0525m,

For inner tube, $f = [1.58(\ln Re) - 3.28]^{-2}$

$$Nu = [(f/2)(Re)\,Pr] \,/\, \{[1.07 + 12.7(f/2)^{1/2}(Pr^{2/3} - 1)\}$$

For Annulus, $Nu = 1.86[(Re\,Pr)(D_h/L)]^{1/3}[(\mu_b/\mu_w)^{0.14}]$,

$f_{cp} = 16/Re$, $f = f_{cp}(\mu_b/\mu_w)^{-0.5}$

Calculate: 1. Velocities in the tube and in the annulus

2. Overall heat transfer coefficient for a clean and fouled heat exchanger
3. The total heat transfer area of the heat exchanger with and without fouling (OS design)
4. The surface area of a hairpin and the number of hairpins
5. Pressure drop inside the tube and in the annulus

Q. 3: A heat exchanger is to be designed to heat raw water 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 13. 8 kg/s. The heat will be transferred 8.3 kg/s of city water coming from a supply at 20°C. A single shell and a single tube pass is preferable. A fouling resistance of 0.000176m^2.K/W is suggested and the surface over design should not be over 35%. A maximum coolant velocity of 1.5 m/s is suggested to prevent erosion. A maximum tube length of 5 m is required because of space limitations. The tube material is carbon steel (K = 60W/mK). Raw water will flow inside of ¾in. Straight tubes (19mm OD with 16mm ID). Tubes are laid out on a square pitch (pitch size = 0.0254m) with a pitch ratio of 1.25. The baffle spacing is approximated by 0.6 of shell diameter, and the baffles cut is set to 25%. The permissible maximum pressure drop on the shell side is 5 psi. The water outlet temperature should not be less 40°C. By selecting a shell diameter of 0.39m according to TEMA standards with 124 tubes for a 2-P shell-and-tube exchanger.

Calculate: (A) heat exchanger length and **04**

(B) Pressure drops for both streams **16**

Assume same heat duty.

Properties of shell-side fluid at 60°C: $\rho = 983.2$ kg/m^3, Cp = 4184 J/kg. K, $\mu = 4.67 \times 10^{-4}$ N.s/m^2, k = 0.652 W/m. K, Pr = 3

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M.E (Thermal Engg) Sub - Design of heat Exchanger

30/4/13

Properties of tube-side fluid at 28.5°C: $\rho = 996.8$ kg/m^3, Cp = 4179 J/kg.K, $\mu = 8.2 \times 10^{-4}$ N.s/m^2, k = 0.610 W/m.K, Pr = 5.65

Take shell-side heat transfer coefficient: $Nu = (h_o.D_e/K) = 0.36\ (D_e.G_s/\mu)^{0.55}\ (C_p.\mu/K)^{1/3}\ (\mu_b/\mu_w)^{0.14}$ for $2 \times 10^3 < Re < 10^6$

μ_w at T_w (44.25°C) = 6.04×10^{-4} N.s/m^2

Take tube-side heat transfer coefficient:

$Nu = (h_i.d_i/K) = [(f/2)\ (Re - 1000)\ Pr] / \{1 + 12.7\ (f/2)^{1/2}\ (Pr^{2/3} - 1)\}$

for $Re > 10^4$

$f = [1.58\ (\ln Re) - 3.28]^{-2}$

for shell-side pressur drop, $\Delta Ps = [f\ G_s^2\ (N_b + 1)\ D_s] / 2\rho\ D_e\ \varphi_s$

$\varphi s = (\mu_b/\mu_w)^{0.14}$ and $f = \exp[0.576 - 0.19\ (\ln Re_s)$

for tube side pressure drop, $\Delta Pt = [4f\ (LN_p/d_i) + 4N_p]\ (\rho\ u_m^2) / 2$

Q. 4: Cold water will be heated by a wastewater stream. Cold water with a flow rate of 140 kg/s enters the gasketed-plate heat exchanger at 22°C and will be heated to 42°C. Wastewater has the same flow rate entering at 65°C and leaving at 45°C. Maximum permissible pressure drop for each stream is 50 psi.

Items	Hot fluid	Cold fluid
Total fouling resistances, m^2.K/W	0.00005	0
Specific heat, KJ/kg.K	4.183	4.178
Viscosity, N.s/m^2	5.09×10^{-4}	7.66×10^{-4}
Thermal conductivity, W/m.k	0.645	0.617
Density, kg /m^3	985	995
Prandtl No. (Pr)	3.31	5.19

Plate material (SS304): Plate thickness = 0.6mm, Chevron angle = 45°, Total number of plates = 105, Enlargement factor = 1.25, Number of passes = one pass / one pass, Overall heat transfer coefficient (clean/fouled) = 8000/4500 W/m^2.K, Total effective area = 110 m^2, All port diameters = 200mm, Compressed plate pack length = 0.38m, Vertical port distance = 1.55m, Horizontal port distance = 0.43m, Effective channel width = 0.63m, Thermal conductivity = 17.5 W/m.k

Take for hot and cold fluid heat transfer coefficient:

$Nu = h.D_h/K = 0.3\ (Re)^{0.663}\ (Pr)^{1/3}\ (\mu_b/\mu_w)^{0.17}$

Take for hot and cold fluid friction coefficient: $f = (1.441)\ /(Re)^{0.206}$

Frictional pressure drop hot and cold fluid = $4f\ [(L_{eff}.\ N_p) / D_h]\ (G^2/2\rho)\ (\mu_b/\mu_w)^{-0.14}$

Calculate: (A) Frictional pressure drop for cold side **10**

(B) Frictional pressure drop for hot side **10**

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M.E (Thermal Engg) Mech, Sub - Design of Steel Structures

Q. 5: Write short notes on (Solve any four): **20**

(1) Overall heat transfer coefficient
(2) Flow induced vibrations and vibration prevention
(3) Plate heat exchanger
(4) Heat exchangers for special services
(5) Corrosion, Erosion, Fouling and water treatment of heat exchanger
(6) Baffles, Baffle cut, Spacing and Orientation

Q. 6: (A) What are the principle components of a shell and tube heat exchanger? Explain the functions of same components (at least five). **05**

(B) What are the basic requirements of heat exchangers? **05**

(C) Explain the fundamentals of heat exchanger design methodology. **05**

(D) What are the basic characteristics of compact heat exchangers? **05**

Q. 7: (A) what are the important factors that influence the heat-transfer performance of tube-fin heat exchangers? **05**

(B) Explain the recommended guidelines for shell-side design of shell and tube heat exchangers. **05**

(C) Explain the basic principles of recuperater and regenerator. **05**

(D) Explain the cleaning techniques of heat exchangers. **05**

Lab

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SARDAR PATEL COLLEGE OF ENGINEERING

[An Autonomous Institution Affiliated to University of Mumbai] 11/6/13.

RE-EXAMINATION, JUNE 2013

SEM / CLASS: SEM II / M. E. (THERMAL ENGG.) **TOTAL MARKS: 100**

M.E.(M) mu fy Thermal sem II

SUBJECT: DESIGN OF HEAT EXCHANGER **TIME: 04 HRS**

MASTER

- Use of Heat and Mass Transfer Data Book is allowed.
- 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 assumptions with proper explanations.

Q. 1: **(A)** What are the advantages and disadvantages of shell-and-tube construction? **05**

(B) Why are baffles used in shell-and-tube heat exchanger? What are the types of fins that are used in heat exchangers? **10**

(C) What are the types of heat exchangers used in a convention plant? Classify them and discuss. **05**

Q. 2: **(A)** Consider a shell-and-tube heat exchanger constructed from a 0.0254m OD tube to cool 6.93 kg/s of a 95% ethyl alcohol solution (c_p=3810 J/kg.K) at a flow rate of 6.30 kg/s. In the heat exchanger, 72 tubes will be used. Assume that the overall coefficient of heat transfer based on the outer-tube area is 568W/m^2.K. Calculate the surface area and the length of the heat exchanger for each of the following arrangements:

1. Parallel-flow shell-and-tube heat exchanger
2. Counter shell-and-tube heat exchanger **15**

(B) What are the different assumptions is to be considered for calculation of heat exchanger? **05**

Q.3 **(A)** What are the different effects of fouling on heat transfer and pressure drop? **10**

(B) What do you mean by fouling resistance, cleanliness factor and percentage over surface? **10**

Q.4 **(A)** A double-pipe heat exchanger is used to condense steam at a rate of 120 kg/hr at 45°C. Cooling water (sea water) enters through the inner tube at a rate of 1.2 kg/s at 15°C. The tube with 25.4mm OD, 22.1mm ID is made of mild steel, k=45/m.K. The heat transfer coefficient on the steam side, h_o, is 7000 W/m^2.K. Calculate the overall heat transfer coefficient under cleaned and fouled conditions.

Take c_p for water at 45°C = 4.18kJ/kg.K and h_{fg} =2392kJ/kg

Properties of water at mean temperature of 23°C are:

ρ = 997kg/m^3, k=0.605W/m.K , μ =9.09 x 10^{-4} Pa.s , Pr = 6.29

Page 01

MECM with Thermal sem II Design of Heat Exchanger 21/6/17

The inside and the outside fouling resistances of the inner tube are:

R_{fi} =0.088 m^2.K/kW for sea water

R_{fo} =0.088 m^2.K/kW for condensate

For inner tube, $f = [1.58(\ln Re) - 3.28]^{-2}$

$$Nu = [(f/2)(Re - 1000) Pr] / \{[1 + 12.7(f/2)^{1/2}(Pr^{2/3} - 1)\}$$ **20**

Q.5 **(A)** What are the different techniques to control fouling? **05**

(B) What are the basic components of shell-and-tube heat exchanger? **05**

(C) What are the different layouts? Explain with neat sketches. **05**

(D) What is the basic design procedure of a heat exchanger? **05**

Q.6 **(A)** What are the different rating programs of the preliminary design of heat exchanger? **05**

(B) What are the different types of compact heat exchanger? Explain any one of them. **05**

(C) What are the different elements of Gasketed-Plate heat exchanger? **05**

(D) Explain the fundamentals of heat exchanger design methodology. **05**

Q.7 **(A)** What is tube pitch? What factors decide the pitch in a particular case? **05**

(B) What are the principle kinds of baffles? **05**

(C) Discuss the use of safety factor in the design of exchanger. **05**

(D) What are the advantages of using the effectiveness-NTU approach? **05**

Page ②

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RE-EXAMINATION, JUNE 2013

M. E (TM) with Thermal, Sem II

Total Marks: 100 Duration: 4 Hours

ME (Thermal Engg.), SEM-II SUBJECT: **Computational Fluid Dynamics**

June 2013 MASTER

- Attempt any **FIVE** questions out of Seven questions.
- Answers to all sub questions should be grouped together.
- Figures to the right indicate full marks.

1. a) Write down the governing equations in integral form and explain the physical meaning of each term in the equation **10**
   b) What is boundary condition? Explain common thermal and flow boundary conditions with appropriate illustrations **10**

2. a) Explain explicit and implicit approaches by using one dimensional heat conduction equation. **10**
   c) With example and illustration explain (i) Structured and Unstructured mesh, and (ii) Conformal and non-conformal mesh. **10**

3. a) (i) Why computer simulation is necessary in fluid flow and heat transfer? **10**
   (ii) What do you understand by validation is numerical computation
   b) (i) Explain the basic approach in solving a problem by numerical method. **10**
   (ii) Differentiate between Guassian elimination, Guass Seidel and TDMA methods.

4. a) What is turbulence? Explain important properties of turbulence. **5**
   b) What is turbulence modeling? Give the list of predictive methods to explain turbulence phenomenon. Explain any two of them. Explain Prandtle's mixing length theory. **15**

5. a) Mathematically represent ADI scheme applying it to a 2D transient conduction. **5**
   b) A cylindrical straight fin (l=5cm, d=1mm) of insulated tip is used for heat transfer enhancement of a body maintained at 200°C. The fin is suddenly exposed to an ambient temperature 25 °C with a convective heat transfer coefficient 50 W/m^2K. To study fin's transient behaviour using explicit scheme, **15**
   (i) Develop a mathematical model of the problem using integral form of energy equation
   (ii) Calculate temperature at equally spaced 6 points along the fin at 4 different time step level for a good convergence.
   (iii) Sketch the temperature variation at all 4 time steps mentioned above.
   (Take thermal diffusivity □ for the material as 10^{-5} m^2/s).

6. a) Discuss about the complexities involved in solving flow problem **5**
   b) Show that the pressure correction equation for incompressible flow is **15**

Page 1

M.E.T.M) with Thermal Sem II Computational Fluid Dynamics

$\frac{\partial^2 P'}{\partial^2 x}+\frac{\partial^2 P'}{\partial^2 y}=\frac{\rho}{\Delta t}R$, Where $P', \Delta t, \rho$ and R are pressure correction, time step, density and mass residue respectively.

7. a) What is upwinding? How does it differ from central difference scheme? Explain both clearly. **5**

   b) Discuss convergence and stability issues associated with one dimensional uncoupled convection-diffusion heat transfer under central difference interpolation of convective terms. **15**

Nov 2013 mem. M.E (Thermal Engg) Sem II, Sub - Computational Fluid Dynamics Master file 07/5/13

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SARDAR PATEL COLLEGE OF ENGINEERING

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END SEMESTER EXAMINATION, MAY 2013

Total Marks: 100 Duration: 4 Hours

ME(Thermal Engg.) Sem – II SUBJECT: **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.

1. a) (i) Discuss a generalized approach of solving thermo-fluid problem.
(ii) Differentiate between modeling and simulation with illustration. **10**

(b) (i) List the advantages and limitation involved in experimental and numerical approach of investigation. **10**
(ii) Explain following terms by giving suitable examples.
- Model validation, - Grid sensitivity
- Stability, - Convergence

2 a) Discuss the fundamental conservation law required for the analysis of a thermo-fluid problem and derive differential form of energy equation where, conduction, convection and heat generation is involved. **10**

b) Discuss the features of Thomas Algorithm and apply it to solve set of equation depicted in following matrix form. **10**

$$\begin{bmatrix} 4 & -1 & 0 & 0 & 0 \\ -1 & 4 & -1 & 0 & 0 \\ 0 & -1 & 4 & -1 & 0 \\ 0 & 0 & -1 & 4 & -1 \\ 0 & 0 & 0 & -1 & 4 \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \end{bmatrix} = \begin{bmatrix} 100 \\ 150 \\ 200 \\ 200 \\ 150 \end{bmatrix}$$

3. a) What is boundary condition? Why is it considered as an essential part of a mathematical modeling? List down different thermal and flow boundary conditions used in numerical calculations. Explain them by giving suitable example. **10**

b) I) What do you understand by **10**
(i) Collocated mesh
ii) Staggered mesh, and
(iii) Semi-staggered mesh
II) Numerically, how flow problem analysis differs from thermal diffusion problem? Discuss the complexity associated with flow problems.

4. a) Write down the steps involved in implementing SIMPLE algorithm? What is pressure correction? Derive an expression for it for a flow problem. **10**

07/5/13

mech.

M.E (Thermal Engg) Sem II, Sub - Computational Fluid Dynamics

b) Prove that for the monotonic convergence of one dimensional convection-diffusion problem the stability is limited by cell **Peclet number** if central difference scheme is used to treat convective terms. **10**

How this restrictions can be avoided. Explain any two methods.

5 a) Discuss the issues related to the numerical treatment of one-dimensional transient conduction. **10**

b) A straight fin (length =5cm) of square cross section (1mm×1mm) of insulated tip is used for dissipating heat from a base body maintained at 500°C. The fin is suddenly exposed to the following environment; **10**

Ambient temperature : 25°C

Convective heat transfer coefficient : 50 W/m^2K.

i) Develop a mathematical model for the problem

ii) Discretize the equation using finite volume method

iii) Calculate temperature at equally spaced 6 points along the fin at 4 different time step level for a good convergence

iv) Plot temperature variation at all time steps.

(Take thermal diffusivity α for the material as 10^{-5} m^2/s).

6. a) Differential between finite difference and finite volume method **5**

b) Write down the finite difference analogous of the equation: **15**

$$\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}=25$$

And solve it for the region bounded by the square $0 \le x \le 4$ and $0 \le y \le 4$, the boundary conditions being

$$T=0 \text{ at } x=0, \quad \text{and} \quad T=8+2y \text{ at } x=4$$

$$T=\frac{1}{2}x^2 \text{ at } y=0, \quad \text{and} \quad T=x^2 \text{ at } y=4$$

Use Gauss-Seidel method to compute the values of T at the internal points.

7. a) Answer following questions: **10**

I) What is alternating direction implicit scheme (ADI)? Where it can be used?

II) Mathematically represent ADI scheme applying it to a 2D transient conduction.

III) How does it differ from explicit and implicit scheme?

List down the advantages of ADI scheme?

b) An infinitely long square steel ingot (k =250 W/mK) of size (24cm × 24cm) is insulated at two opposite side and exposed to red hot temperature of 500°C on other two sides. **10**

(i) Represent a suitable computational domain for the numerical analysis with proper reasoning.

(ii) Write the governing equation with initial and boundary condition.

(iii) Discretize the domain into 6×6 mesh size and develop nodal equation.

(iv) Suggest appropriate method with reasoning to estimate nodal values for the present case.

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RE-EXAM JUNE-2013

Total Marks:- 100 M. E (TM) with Thermal. Sem II. **Duration:- 4 Hrs.**

M.E.(THERMAL) SEM-II

EXPERIMENTAL ANALYSIS & INSTRUMENTATION

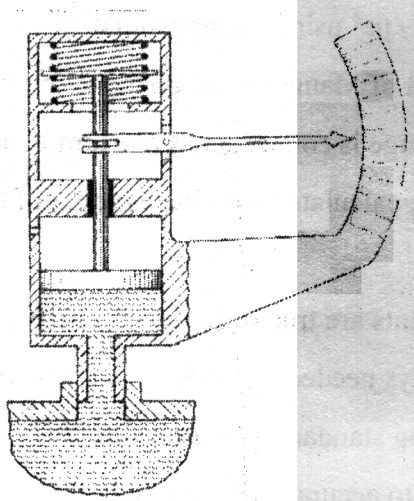
MASTER

25/6/13.

- Attempt any **FIVE** questions out of **SEVEN** questions.
- Answers to all sub questions should be grouped together.
- Assume suitable data wherever necessary and state the same.
- Draw neat sketches to illustrate your answers.

Q1. a) Explain:- i) Method of high gain feedback in a control system ii) Method of Signal Filtering with neat sketches and illustrative examples. (10)

b) Explain functional elements of a Measurement System with generalized block diagram. Illustrate for a rudimentary pressure gauge shown in figure below. (10)



Q2. a) State different types of electromechanical transducers in a measurement system. Explain with neat sketch and principle involved, the piezoelectric accelerometer. (10)

b) A small cantilever beam is constructed for measurement of force F. It is made up of spring steel having modulus of elasticity E= 200 x 10^9 N/m^2. The beam is 4.75 mm wide and 0.9 mm thick with an estimated error of ± 0.75 mm. Length of the beam is 25 ± 0.05 mm. A LVDT is used for measuring the displacement of the beam. The displacement of the beam is 2.5 mm with an estimated error of ± 0.025 mm. Force F is computed by expression $F = \frac{3.E.b.d^3.x}{12.L^3}$; b= width of the beam (mm), d = thickness of beam (mm) , L= length of beam (m), x= displacement of LVDT (mm)
Calculate the nominal value of force F and absolute errors in the computed force F. (10)

Page 1

M.E(M) with Thermal Sem II 25/6/13 Exp. Anal. & Instr.

Q3. a) Explain Data logging and Acquisition system. Illustrate with a suitable example the need of data logging and acquisition in an experimentation. (10)

b) Explain Electrical methods of temperature measurement with neat sketches & compare them. (10)

Q4. a) List various types of pyrometers. Explain construction, working, advantages & limitations of Total Radiation Pyrometer with a neat sketch. (10)

b) Name various vacuum gauges. Explain construction & working of Knudsen gauge with a neat sketch. (10)

Q5 .a) Discuss necessity of Temperature compensation in Strain gauges. State various methods for the same & explain any one in details. A Strain Gauge with a gauge factor of 4 has a resistance of500 Ω. It is to be used in a test in which the strain to be measured may be as low as5×10^{-6}. What will be the change in resistance of gauge? (10)

b) State various flow measurement methods. Explain principle, construction & working, merits & demerits of Laser Doppler Anemometer with a neat sketch. (10)

Q6. a) Describe the construction & working of Bridgman Gauge with a neat sketch. A Bridgman gauge is used to measure the pressure of 70 MN/m^2 using a Manganin element of resistance100 ohm at atmospheric pressure. Resistance co-efficient of Manganin is $25 \times 10^{-12}/Pa$ .Calculate the resistance of gauge under high pressure condition. The gauge is connected as one arm in a Wheatstone Bridge whose all other arms have exactly the value of100 Ω, calculate the voltage output of the bridge for a constant bridge input voltage source of 24V. (10)

b) State whether following statements are true or false and justify the same. (10)

1) Auxiliary power supply is always needed for an instrument to function.

2) For primary calibration, working standards are used.

3) The term traceability is related to accuracy of the standard.

4) The output of a transducer is always electrical.

5) A mercury in glass thermometer has in-built amplifying element.

Q7. Write short notes on any **FOUR** of the following:- (20)

a) Intelligent instruments
b) Stroboscope
c) Humidity measurement
d) Shadow graph techniques
e) Spectrometry
f) Load Cell

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03/5/13

MAY-2013

Marks:- 100 Mech. **Time:- 4 Hrs.**

M.E.(THERMAL) SEM-II

EXPERIMENTAL ANALYSIS & INSTRUMENTATION

- **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 and state the same.**
- **Draw neat sketches to illustrate your answers.**

Master file.

Q1. a) Explain Desired, Modifying and Interfering inputs associated with a measurement system with block diagram. List various methods of minimizing the effect of interfering inputs and explain any one of them with suitable example. (10)

b) Explain generalized block diagram with functional elements for a Measurement System. Illustrate with the example of a pressure thermometer. (10)

Q2.a) Explain in details different types of errors encountered in a measurement system with reasons for occurence and methods of elimination of the same. (10)

b) A rectangular steel rod of width b & thickness t is supported at its ends and is loaded at the centre by load W. The length of the rod between the supports is l, E is Young's Modulus of Elasticity in N/m^2 & deflection at the centre is δ.

The expression for which is $\delta = \frac{W.l^2}{4E.b.d^3}$. Measurement gives following data:-

$b = 4.942 \pm 0.042\ cm$; $d = 5.5250 \pm 0.025\ cm$; $l = 1.000\ m \pm 0.5\ mm$,

$\delta = 2.622 \pm 2.25\%\ of\ \delta\ in\ mm$; $W = 1500\ N$

Calculate the nominal value of and absolute error in the computation of E. (10)

Q3. a) Explain Data logging and Acquisition system. Illustrate with a suitable example the need of data logging and acquisition in an experimentation. (10)

b) Discuss necessity of Temperature compensation in Strain gauges. State various methods for the same & explain any one in details. A Strain Gauge with a gauge factor of 4 has a resistance of 500 Ω. It is to be used in attest in which the strain to be measured may be as low as 5×10^{-6} . What will be the change in resistance of gauge? (10)

Q4. a) Describe the construction & working of Bridgman Gauge with a neat sketch.
A Bridgman gauge is used to measure the pressure of 70 MN/m^2 using a Manganin element of resistance100 *ohm* at atmospheric pressure. Resistance co-efficient of Manganin is $25 \times 10^{-12}/Pa$ Calculate the resistance of gauge under high pressure condition. The gauge is connected as one arm in a Wheatstone Bridge whose all other arms have exactly the value of100 Ω, calculate the voltage output of the bridge for a constant bridge input voltage source of 24V. (10)

b) Name various vacuum gauges. Explain construction & working of i) Thermocouple gauge & ii) Pirani gauge with a neat sketch. (10)

Page 1 of 2

M.E. (Thermal) Sem - II

Experimental Analysis & Instrumentation.

Q5. a) List various types of pyrometers. Explain construction, working, advantages & limitations of disappearing filament optical pyrometer with a neat sketch. (10)

b) Explain Electrical methods of temperature measurement with neat sketches & compare them. (10)

Q6. a) State various flow measurement methods. Explain principle, construction & working, merits & demerits of Laser Doppler Anemometer with a neat sketch. (10)

b) List various Electro-mechanical Transducers used for measurement of Thermo-physical properties. Explain with neat sketches, principle, construction & working, merits & demerits of any two of them. (10)

Q7. Write short notes on any THREE of the following:- (20)

a) Intelligent instruments
b) Heat Flux Measurement
c) Humidity measurement
d) LVDT
e) Stroboscope
f) Piezoelectric Accelerometers.

Page ②

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09/5/2013

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End Sem Examination May 2013

Total Marks: 100 mem wise. Duration: 4Hours

CLASS: M.E.(Thermal), Sem: II SUBJECT: Advanced Turbo Machinery

- Attempt any **Five** questions out of seven questions.
- Figures to the right indicate full marks.
- Make any suitable assumption if needed with proper reasoning.

1.(a) Draw velocity triangles in the case of R< 0.5, R=0.5, R> 0.5, in the case of,
(i) Apex symmetry (common apex),
(ii) Tangential speed as a common base (u is common) 12

(b) Define degree of reaction. Obtain an expression for degree of reaction and show that for 50% degree of reaction the blades are symmetrical. 8

2. Air flows through an air turbine where its stagnation pressure is decreased in the ratio 5:1. The total to total efficiency is 0.82 and the air flow rate is 5.5Kg/s. The inlet total temperature is 280K. Calculate (a) The actual power output (b) the actual exit total temperature(c) the actual exit static temperature if the exit flow velocity is 110m/s, and (d) the total to static efficiency of the device. 08

Define total-to-total and static-to-static efficiencies for compressor and turbine stage and derive expressions of it, in terms of pressure ratios. 12

3. (a) Derive an expression for the degree of reaction of a centrifugal blower in terms of the flow co-efficient and impeller blade exit angle. 08

(b) Show that $\square = 4(1-R)$ 02

(c) A centrifugal blower with a radial impeller produces a pressure equivalent to 100cm column of water. The pressure and temperature at its entry are 0.98bar and 310K. The electric motor driving the blower runs at 3000rpm. The efficiencies of the fan and drive are 82% and 88% respectively. The radial velocity remains constant and has a value of $0.2u_2$.The velocity at the inlet eye is $0.4\ u_2$ If the blower handles $300m^3$/min of air at the entry conditions, determine:

(i) Power required by the electric motor,
(ii) Impeller diameter,
(iii) Inner diameter of the blade ring,
(iv) Air angle at entry,
(v) Impeller width at entry & exit, 10

4. (a) Discuss Euler's characteristic curves of centrifugal blower for backward, radial and forward curved vanes. 12

09/5/2013

M.E (sem II) Thermal Engg. Sub - Advanced Turbo Machinery

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(b) A centrifugal blower takes in 180m^3/min of air at p_1= 1.013bar and t_1= 43°C, and delivers it at 750mm W.G. Taking the efficiencies of the blower and drive as 80% and 82%, respectively, determine the power required to drive the blower and the state of air at exit. 08

5. (A) Sketch an axial fan stage with the inlet nozzle, UGVs (R>1) outlet diffuser.
Draw the velocity triangle at the entry & exit of the impeller.
Prove the following relations:
(a) $(\Delta P_0)_{st} = \rho u^2 (\Phi \tan\beta_2 - 1)$
(b) $w_{st} = u2 (\Phi \tan\beta_2 - 1)$
(c) $R = (1 + \Phi \tan\beta_2)/2$ 12

(B)An axial fan stage consisting of only a rotor has the following data: 08

Rotor blade air angle at exit	10°
Tip diameter	65cm
Hub diameter	35cm
Rotational speed	960rpm
Power required	1kW
Flow coefficient	0.245

(Inlet flow conditions p_1 = 1.02bar, T_1 = 316K)
Determine the rotor blade angle at the entry, the flow rate, stage pressure rise, overall efficiency, degree of reaction.

6. (a) Explain fan noise and discuss the various noise control techniques in detail. 12
(b)Explain detail procedure for carrying out the test of fan with standard set up. 08

7. (a)Explain various industrial applications of blowers and fans. 08
(b) With the help of neat sketch explain main components of centrifugal blower/fan with their functions. Also explain working of blower and derive expression for power required to drive it. 12

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First Half 2013

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.

Q1 **a)** What is role of piping & scope of piping. **04**

b) What are the inputs received and outputs given by piping Engineer? **06**

c) What are the methods of welding used for piping fabrication? **06**

d) Write a note on fabrication precaution. **04**

Q2 **a)** The following data refers to a 4 piece Miter: **10**

Plate Thickness	= 0.322 inch
Outer diameter of pipe	= 8.66 inch
Nominal diameter of pipe	= 8 inch
Miter Spacing	= 6.5 inch

Calculate Stress Intensification Factor & Flexibility Factor.

Also check whether Miter is closely spaced or widely spaced.

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) Petroleum Gas Rules 3) ASME – ANSI B31.1 & B31.3

b) A water pump has to deliver water from a reservoir at a rate of 225 m^3/hr at 20°C **10** through a new ERW pipe of NB 200mm to an overhead tank at10m height. The pipe length is supposed to be 100m, 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.

Data:

M.E (Thermal Engg) - II Sub - piping Engineering

Coefficient of resistance ζ for NB 200mm pipe size:

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

Friction factor for commercial pipe NB 200mm $\lambda = 0.028$

Q4 a) Draw a neat schematic diagram. Write objective, what should be shown & what should not be shown in Piping & Instrumentation Diagram. 10

b) Draw neat functional diagram, explain the working, and write advantages, limitations and applications of gate valve. 10

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)	= 200 mm
Outer diameter of header pipe	= 219 mm
Minimum thickness of header pipe	= 8 mm
Nominal diameter of branch pipe (Schedule 20)	= 100 mm
Outer diameter of branch pipe	= 112 mm
Minimum thickness of branch pipe	= 6 mm
Design pressure	= 1.5 N/mm^2
Design Temperature	= 250°C
Corrosion allowance	= 1.5 mm

Allowable stress for ASTM A53 Grade B at design temperature = 105 N/mm^2

(For both Header & Branch pipe)

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 a note on Role of computers in piping 05

Q7 a) Write notes on (Any four): 20

i) cathodic protection of piping.

ii) Welders' qualification.

iii) Expansion loops.

iv) Stress Intensification Factor & Flexibility Factor.

v) Jacketed piping.