Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)

Munshi Nagar, Andheri (West), Mumbai – 400058.

Re-Exam

June 2018

Max. Marks: 100

Class: F.Y. M. Tech (Thermal)

Semester: II

Name of the Course: Experimental Analysis and Instrumentation

Duration: 3 Hrs.

Program: M. Tech Thermal

Course Code : MTTH202

Instructions:

1. Answer to question no.1 is compulsory.
2. Attempt any four out of remaining six questions.
3. Answer to sub questions should be grouped together.
4. Assume suitable data if necessary.

Q. No.		Module No./CO. No.	Max. Marks
Q.1	Write Short Notes on **any five** of the following:		
(a)	Uncertainty Analysis & Propagation of Uncertainties	01/02	04
(b)	Dynamic Characteristics	02/01	04
(c)	Resistive displacement transducers	03/01	04
(d)	Total Radiation Pyrometers	04/01	04
(e)	Working of simple hydrometer	05/01	04
(f)	Gauge factor of strain gauge	06/01	04
(g)	Types of Filters	07/04	04
Q.2 (a)	Describe different types of errors in instrumentation, their causes and remedies.	01/01	12
(b)	Define following static characteristics: i) Linearity ii) Hysteresis	02/02	08
Q.3 (a)	Derive the general mathematical equation of a thermal system? Also derive the time domain response for first order unit step input.	02/02	10
(b)	Explain construction and working of LVDT accelerometer? State its advantages and disadvantages.	03/01	10
Q.4 (a)	Explain construction and working of Rotameter. State its advantages and disadvantages.	04/03	10

(b)	Describe different types of shaft encoders.	03/04	10
Q.5 (a)	Explain construction and working of Thermocouple? List different types of thermocouples?	04/01	10
(b)	Why is temperature compensation required in strain gauges? Explain four arms method of temperature compensation?	06/03	10
Q.6 (a)	Explain any one procedure to measure thermal conductivity of gases.	05/03	10
(b)	Describe the working of Null type of Bridge Circuit.	07/04	10
Q.7 (a)	Explain construction and working of resistive hygrometers? State its advantages and disadvantages.	06/03	10
(b)	Explain any one analog to digital converter? Give any two operational amplifiers.	07/04	10
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KT EXAMINATION,
June 2018

Program: M.Tech. (Mechanical) Thermal Engineering **Date: 01/06/2018**
Duration: 3 hrs.
Course code: MTTH101 **Max. Marks: 100**
Name of the Course: Transport Phenomena **Semester: I**

Instructions:

- Question 1 is compulsory. Attempt any FOUR questions out of SIX.
- Make any suitable assumption if needed.
- Draw neat diagrams where ever necessary.
- Answer to all sub questions should be grouped together.
- Use of HMT data book is permitted.

Q. No		Max Mark	CO No.	Mod. No.
Q1	(a) What is transport phenomenon in context to a thermal system? Discuss different transport quantities associated to thermal system in detail.	10	2	1
	(b) Write boundary layer equation under the assumption proposed by Prandtl. What is Von Karman's Momentum Integral equation? Derive a mathematical expression for it.	10	1	5
Q2	(a) Water at 25°C enters a tank at a rate of 5 kg/min. The tank contains 150 kg of water and is provided with an exit flow channel which discharges at the rate of 5 kg/min. water in the tank is well mixed. If the tank is insulated and an electric heater is suddenly placed in the tank generating heat at the constant rate of 20,000 kJ/h. calculate time required for the exit temperature to reach 50°C. What will the exit temperature be when steady state condition is reached? Neglect mass of the tank.	10	3	1
	(b) Assume a steady incompressible laminar parallel flow between two parallel plates separated by a small gap 'b' and moving in opposite direction with equal velocity. Develop a governing equation for the problem using 2D-Navier Stokes equation and derive an expression for velocity profile. Estimate following quantities: Maximum and average velocity, (ii) Volume flow rate, and (iii) Pressure drop	10	3	4
Q3	(a) Discuss following TWO terms: i. Velocity profile of turbulent flow ii. Flow separation iii. Developed and Developing flow	10	1	3-5

	(b) What is transient heat conduction? Explain it with suitable examples. Listing all assumptions made in lumped parameter model analysis develop a governing equation and get a general solution. State the condition of its validity.	**10**	**1**	**6**
Q4	**(a)** Air at 20°C flows past an 800 mm long plate at a velocity of 45 m/s. If the surface of the plate is maintained at 300°C, Determine: i) The heat transferred from the entire plate length to air taking into consideration both laminar and turbulent portion of the boundary layer. ii) The percentage error if the boundary layer is assumed to be turbulent nature from very leading edge of the plate. Use HMT data book for additional information.	**10**	**3**	**6**
	(b) Discuss you're understating of mass, momentum and energy transport with respect to cooling tower. Suggest your ideas to enhance the performance of the cooling tower.	**10**	**4**	**6,7**
Q5	**(a)** The velocity components in a 2D incompressible flow field are expressed as $V = (y^2 + 2xz)i + (-2yz + x^2yz)j + \left(\frac{1}{2}x^2z^2 + x^3y^4\right)$ Determine: i. Is the flow possible? ii. Is the flow steady or unsteady? iii. Is it possible incompressible flow? iv. Find an expression for shear stress.	**10**	**3**	**2**
	(b) Explain different mechanisms of mass transport.	**10**	**1**	**7**
Q6	**(a)** What is heat transfer coefficient? List down the important parameters influencing it. Show the variation of *h* in laminar, transition and turbulent regions and explain the reasons for such variation.	**10**	**1**	**6**
	(b) Why do bowlers rub the ball before bowling in a cricket match? Explain your understanding from Fluid Mechanics aspect of Reverse Swing. Recommend the possible ways to swing the ball.	**10**	**4**	**5**
Q7	**With sufficient illustration answer following questions:** i. What is the need of thermodynamic laws for the analysis of thermal .a system? ii. What do you understand by boundary condition? Write about common thermal and flow boundary conditions. iii. Discuss characteristic features of a turbulent flow. iv. Closure problem in turbulence	**20**	**1,2**	**1-6**

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RE EXAMINATION
June 2018

Program: M. Tech. (Mechanical) Thermal Engineering **Duration: 3 hrs.**
Course code: MTTH201 **Max.Marks: 100**
Name of the Course: Design of Heat Exchanger **Semester: II**

Instructions:

- **Question 1 is compulsory**. Attempt **any FOUR** questions out of SIX.
- Make any suitable assumptions if needed.
- Draw neat diagrams where ever necessary.
- Answer to all sub questions should be grouped together.
- Use of HMT data book is permitted.

Q. No		Mark	CO No.	M. No.
Q1	**Answer the following questions:** a) Why are the baffles used in shell and tube heat exchangers? Where are fins used? What are the types of fins that are used in heat exchangers? b) What are the different inputs to be considered for sizing and rating of shell and tube heat exchanger? c) Name the basic components of shell and tube heat exchanger and Explain tube layouts with respect to a shell and tube exchanger. d) Explain the effects of fouling on heat transfer, pressure drop of heat exchanger. e) What are the main selection criteria of a heat exchanger?	20	01	1-7
Q2	Water at a flow rate of 5000 kg/hr will be heated from 20°C to 35°C by hot water at 140°C. A 15°C hot water temperature drop is allowed. A number of 3.5 m hairpins of 3 in. (ID = 0.0779 m) by 2 in. (ID = 0.0525 m, OD = 0.0603 m) counterflow double-pipe heat exchangers with annuli and pipes, each connected in series, will be used. Hot water flows through the inner tube. Fouling factors are: R_{fi} = 0.000176 m^2.K/ W, R_{fo}, = 0.000352 m^2. K/W.Assume that the pipe is made of carbon steel (k = 54 W/m.K). The heat exchanger is insulated against heat losses. 1. Calculate the number of hairpins. 2. Calculate the pressure drops. Use following correlations: Use friction factor f (for turbulent flow): $f = [1.58 \ln(Re) - 3.28]^{-2}$ and for laminar flow: $f = \frac{16}{Re}$ for laminar flow: $Nu = 1.86\left(\frac{D_h\, Re\, Pr}{L}\right)^{0.33}$ for turbulent flow: $$Nu_b = \frac{\left(\frac{f}{2}\right)(Re-1000)Pr}{1+12.7\left(\frac{f}{2}\right)^{\frac{1}{2}}\left(Pr^{\frac{2}{3}}-1\right)}$$	20	03, 04	02
Q3	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	20	03, 04	04

with a mass flow rate of 50,000 kg/hr. The heat will be transferred to 30,000 kg/hr of city water coming from a supply at 17°C (Cp = 4184 J/kg.K). A single shell and a single tube pass is preferable. A fouling resistance of 0.000176 m^2.K/W is suggested and the surface over design should not be over 35%. A maxi-mum coolant velocity of 1.5 m/s is suggested to prevent erosion. A maxi-mum tube length of 5 m is required because of space limitations. The tube material is carbon steel (k = 60 W/m.K). Raw water will flow inside of 3/4-in. straight tubes (19 mm OD with 16 mm ID). Tubes are laid out on a square pitch with a pitch ratio of 1.25. The baffle spacing is approximated by 0.6 of shell diameter and the baffle cut is set to 25%. The permissible maximum pressure drop on the shell side is 5.0 psi. The water outlet temperature should not be less than 40°C. Perform the preliminary analysis. By selecting a shell diameter of 15.25 in, according to TEMA standards with 124 tubes for a 2-P shell-and-tube heat exchanger, re-rate this heat exchanger for the given process specifications by using the Kern method. Note that heat duty is fixed, so the heat exchanger length and pressure drops for both streams are to be calculated.

Use following correlations:

For Shell side, $Nu = 0.36 Re^{0.55} Pr^{\frac{1}{3}}$

For tube $f = [1.58\ ln(Re) - 3.28]^{-2}$ $Nu = \frac{\left(\frac{f}{2}\right)(Re-1000).Pr}{1+12.7\,(Pr^{0.667}-1)\sqrt{\frac{f}{2}}}$

Q4 Cold water will be heated by a wastewater stream. The 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. The process specifications are as follows: **20** **03, 04** **06**

Items	Hot Fluid	Cold Fluid
Fluids	Wastewater	Cooling water
Flow rates (kg/s)	140	140
Temperature in (°C)	65	22
Temperature out (°C)	45	42
Maximum permissible pressure drop (psi)	50	50
Total fouling resistance ($m^2 \cdot K/W$)	0.00005	0
Specific heat (J/kg · K)	4183	4178
Viscosity ($N \cdot s/m^2$)	5.09×10^{-4}	7.66×10^{-4}
Thermal conductivity (W/m · K)	0.645	0.617
Density (kg/m^3)	985	995
Prandtl number	3.31	5.19

The constructional data for the proposed plate heat exchanger are:

Plate Material	SS304
Plate thickness (mm)	0.6
Chevron angle (degrees)	45
Total number of plates	105
Enlargement factor, ϕ	1.25
Number of passes	One pass/one pass
Overall heat transfer coefficient (clean/fouled) $W/m^2 \cdot K$	8000/4500
Total effective area (m^2)	110
All port diameters (mm)	200
Compressed plate pack length, L_c, (m)	0.38
Vertical port distance, L_v, (m)	1.55
Horizontal port distance, L_h, (m)	0.43
Effective channel width, L_w, (m)	0.63
Thermal conductivity of the plate material (SS304), W/m · K	17.5

The waste water has the same flow rate entering at 65°C and leaving at 45°C. The maximum permissible pressure drop for each stream is 50 psi.

	$Nu = (hD_h/k) = 0.3\ (Re)^{0.663}\ (Pr)^{0.333}\ (\mu_b/\mu_w)^{0.14}$ Take friction coefficient for hot and cold fluids as $f = (1.441) / (Re)^{0.206}$			
Q5	A shell-and-tube type condenser is to be designed for a coal fired power station of 200 MW. Steam enters the turbine at 5 MPa and 400°C (h_f = 3195.7 kJ/kg). The condenser pressure is 10 KPa (0.1 bar). The thermodynamic efficiency of the turbine = 0.85. The actual enthalpy of steam entering the condenser at 0.1 bar is calculated to be 2268.4 kJ/kg with 80% quality. The condenser is to be designed without sub-cooling. A single tube pass is used and the cooling water velocity is assumed to be 2 m/s. Cooling water is available at 20°C and can exit the condenser at 30°C. Allowable total pressure drop on tube side is 35 KPa. The tube wall thermal conductivity k = 111 W/mK. Outside diameter of the tubes do = 0.0254 m, Inside diameter of the tubes di = 0.02291 m. Tube wall thermal conductivity, k = 111 W/m.K., R_{fi} = 0.000176 m^2.K/ W, R_{fo}, = 0.00009 m^2. K/W. For Shell side, $Nu = 0.36Re^{0.55}Pr^{\frac{1}{3}}$ For tube $f = [1.58\ ln(Re) - 3.28]^{-2}$ $Nu = \dfrac{\left(\frac{f}{2}\right)(Re - 1000).Pr}{1 + 12.7\ (Pr^{0.667} - 1)\sqrt{\frac{f}{2}}}$	**20**	**03, 04**	**07**
Q6	a) What do you mean by enhancement ratio? What are the objectives of design of compact heat exchanger?	**10**	**01**	**06**
	b) What are the different classifications of heat exchangers? Explain each type in brief. Draw the temperature profile diagram of following heat exchangers: i. Condenser ii. Evaporator iii. Counter flow arrangement iv. Parallel flow arrangement	**10**	**01**	**01**
Q7	**Write short notes on (Solve any four):** (1) Overall and variable heat transfer coefficient (2) Flow induced vibrations and vibration prevention in heat exchangers (3) Plate heat exchanger (4) Heat exchangers for special services (5) Corrosion, Erosion, Fouling and Water treatment in heat exchangers	**20**	**01**	**1-7**

PTO

Table 1. Heat Exchanger Tube Data

Nominal Pipe Size (in.)	Outside Diameter (in.)	Schedule Number or Weight	Wall Thickness (in.)	Inside Diameter (in.)	Surface Area		Cross-Sectional Area	
					Outside (ft.²/ft.)	Inside (ft.²/ft.)	Metal Area (in.²)	Flow Area (in.²)
		40	0.113	0.824	0.275	0.216	0.333	0.533
3/4	1.05	80	0.154	0.742	0.275	0.194	0.434	0.432
		40	0.133	1.049	0.344	0.275	0.494	0.864
1	1.315	80	0.179	0.957	0.344	0.250	0.639	0.719
		40	0.140	1.38	0.434	0.361	0.668	1.496
1-1/4	1.660	80	0.191	1.278	0.434	0.334	0.881	1.283
		40	0.145	1.61	0.497	0.421	0.799	2.036
1-1/2	1.900	80	0.200	1.50	0.497	0.393	1.068	1.767
		40	0.154	2.067	0.622	0.541	1.074	3.356
2	2.375	80	0.218	1.939	0.622	0.508	1.477	2.953
		40	0.203	2.469	0.753	0.646	1.704	4.79
2-1/2	2.875	80	0.276	2.323	0.753	0.608	2.254	4.24
		40	0.216	3.068	0.916	0.803	2.228	7.30
3	3.5	80	0.300	2.900	0.916	0.759	3.106	6.60
		40	0.226	3.548	1.047	0.929	2.680	9.89
3-1/2	4.0	80	0.318	3.364	1.047	0.881	3.678	8.89
		40	0.237	4.026	1.178	1.054	3.17	12.73
4	4.5	80	0.337	3.826	1.178	1.002	4.41	11.50
		10 S	0.134	5.295	1.456	1.386	2.29	22.02
5	5.563	40	0.258	5.047	1.456	1.321	4.30	20.01
		80	0.375	4.813	1.456	1.260	6.11	18.19
		10 S	0.134	6.357	1.734	1.664	2.73	31.7
6	6.625	40	0.280	6.065	1.734	1.588	5.58	28.9
		80	0.432	5.761	1.734	1.508	8.40	26.1
		10 S	0.148	8.329	2.258	2.180	3.94	54.5
8	8.625	30	0.277	8.071	2.258	2.113	7.26	51.2
		80	0.500	7.625	2.258	1.996	12.76	45.7
		10 S	0.165	10.420	2.81	2.73	5.49	85.3
10	10.75	30	0.279	10.192	2.81	2.67	9.18	81.6
		Extra heavy	0.500	9.750	2.81	2.55	16.10	74.7
		10 S	0.180	12.390	3.34	3.24	7.11	120.6
	12.75	30	0.330	12.09	3.34	3.17	12.88	114.8
		Extra heavy	0.500	11.75	3.34	3.08	19.24	108.4
		10	0.250	13.5	3.67	3.53	10.80	143.1
14	14.0	Standard	0.375	13.25	3.67	3.47	16.05	137.9
		Extra heavy	0.500	13.00	3.67	3.40	21.21	132.7
		10	0.250	15.50	4.19	4.06	12.37	188.7
16	16.0	Standard	0.375	15.25	4.19	3.99	18.41	182.7
		Extra heavy	0.500	15.00	4.19	3.93	24.35	176.7
		10 S	0.188	17.624	4.71	4.61	10.52	243.9
18	18.0	Standard	0.375	17.25	4.71	4.52	20.76	233.7
		Extra heavy	0.500	17.00	4.71	4.45	27.49	227.0

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Re-Exam
June 2018

Max. Marks: 100 | Duration: 3 Hrs.

Class: F.Y. M. Tech (Thermal) | Semester: II | Program: M. Tech Thermal

Name of the Course: Computational Fluid Dynamics | Course Code : MTTH203

Instructions:

1. Answer to question no.1 is compulsory.
2. Attempt any four out of remaining six questions.
3. Answer of sub questions should be grouped together only.
4. Assume suitable data if necessary.

Q. No.		Module No./CO. No.	Max. Mark
Q.1(a)	Describe computational fluid dynamics? What are its merits and demerits?	01/02	10
(b)	What are successive over relaxation and successive under relaxation techniques?	02/01	06
(c)	Distinguish between Experimental and Numerical Approach.	01/01	04
Q.2 (a)	Explain mathematical modeling and its importance?	01/02	06
(b)	Solve the following equations with TDMA method and Gauss Elimination method. Compare the results? $2.25x_1 - x_2 = 1$, $-x_1 + 2.25x_2 - x_3 = 0$, $-x_2 + 2.25x_3 - x_4 = 0$, $-2x_3 + 2.25x_4 = 0$.	02/03	10
(c)	Give mathematical form of different Partial Differential Equations?	03/01	04
Q.3 (a)	Identify whether following equations are linear or non- linear and also give how many boundary conditions will be required to solve these equations. Justify your answer. i) $u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = 0$ ii) $\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0$	03/01	06
(b)	Distinguish Between Structured and Unstructured Grid?	04/02	06
(c)	Explain in short Gauss Seidel Method?	02/01	04

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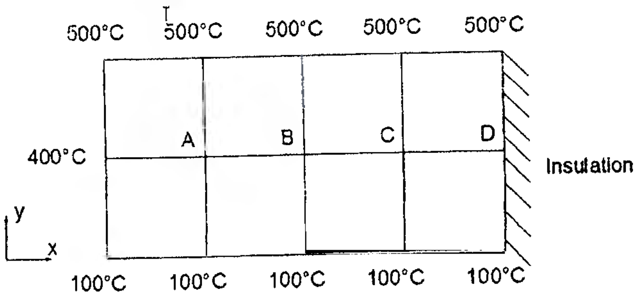
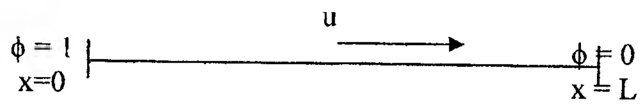
Q.4 (a)	Derive the continuity equation for a fluid element stationary in the flow?	03/01	10
(b)	Derive the forward and backward difference form of $\frac{\partial u}{\partial x}$ and comment on the accuracy of each.	04/01	04
(c)	A one dimensional, unsteady state, heat conduction problem without heat generation is to be analyzed. i) Write the governing equation ii) Discretize the governing equation with finite difference method via implicit method and write the temperature distribution equation. iii) State the stability criteria for implicit method.	05/04	06
Q.5 (a)	State the importance of Grid Independence Test?	04/01	06
(b)	A two dimensional, steady state, heat conduction problem without heat generation is to be analyzed. Figure shown below. Thermal Conductivity k = 1000 W/m-K, Cross sectional area A = 10 x 10^{-3} m^2. Assume $\Delta x = 0.1m$  i) Write the governing equation ii) Discretize the governing equations with finite difference method and write the general discretized equation. iii) Write the equations at all nodes and solve them to get temperature distribution.	05/04	10
(c)	i) Write the governing equation for one dimensional, unsteady state convection diffusion heat transfer problem. ii) Discretize the equation with upstream term and implicit method.	06/04	04
Q.6 (a)	Comment on the accuracy of Explicit, Implicit and Crank Nicholson Method of discretiziation for one dimensional, unsteady state heat conduction problem.	05/01	04
(b)	A property ϕ is transported by means of convection and diffusion through the one dimensional domain sketched in fig. 1 below. L = 1m, $\rho = 1$ kg/m^3, $\Gamma = 0.1$ kg/m-s. a) Give the governing equation for the problem.	06/04	10

	b) Derive the discretised equation of the governing equation by the central differencing scheme and finite volume method. Calculate ϕ by taking five equally spaced cells and u = 0.1 m/s  Fig. 1		
(c)	Write the momentum equations for x and y directions. What are the complexities in solving the Navier stokes equations?	07/01	06
Q.7 (a)	Explain the following schemes for convection diffusion problem: i) Power Law ii) Hybrid Law	06/01	06
(b)	Explain any one turbulent model and its applications.	07/02	04
(c)	Derive the Stream function – Vorticity Method. State the Algorithm.	07/04	10

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End Semester Exam

May 2018

Program: **M.Tech. in Mechanical Engineering** | Date: **23 May 18**

Class: **First Year M.Tech. (Mechanical)** | Duration: **3 Hr.**

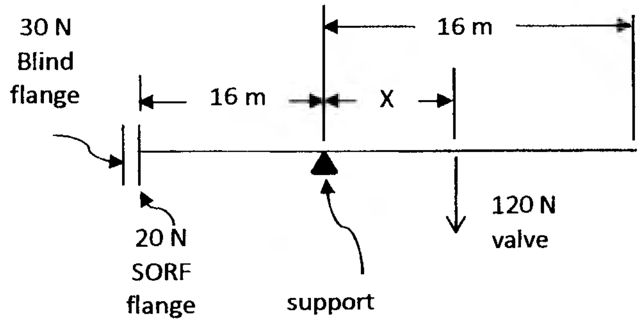
Course code: **MTTH214** | Max. Points: **100**

Name of the Course: **Piping Engineering (Elective IV)** | Semester: **II**

Instructions:

- Attempt any five questions.

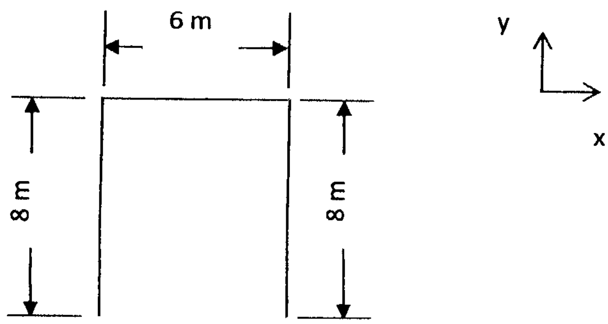
		Max. Points	CO No.	Module No.
Q1	A) Build an engineering flow diagram of the Piping discipline indicating the major deliverables, and multi-discipline information flow.	(8)	1	1
	B) Discuss the advantages of the PMS	(2)	1	1
	C) Show with sketches (any three) how you will convert a rigid piping system into a flexible one.	(6)	1	6
	D) Find the distance "x" where the valve will be placed. Weight of pipe is 50 N/m	(4)	1	6



		Max. Points	CO No.	Module No.
Q2	A) Discuss the following:		2	2
	• Various types of gaskets.	(5)		
	• Slip on flanges	(2)		
	• Swages	(2)		
	• Fig 8 blanks	(1)		
	B) Build a table for various compatible product forms	(5)		
	C) Discuss the pipe materials that you would specify for low (temp < -29 deg C) and high temperature service (temp > 425 deg C)	(5)		

Table for Q2 B):

Basic chemistry	Pipe	Wrought fittings	Flange	Casting
Carbon steel	ASTM A 53 Gr. B	-	-	-
Stainless steel	ASTM A 312 TP 304	-	-	-

Q3	Discuss the important features of the below codes and standards. A) ASME B31.3 B) Indian Boiler Regulation C) Factories Act	 (10) (5) (5)	2	3
Q4	A) Crude oil of specific gravity 0.8 is flowing in a 200 NB (OD 219.1 mm) pipeline. 100 deg C is the design temperature and 10 MPa is internal design pressure. Material is carbon steel seamless (S=135 MPa). Find the minimum design thickness of pipe. B) Calculate thickness of 6" bend (OD=168 mm) and R=3D, Allowable stress =135 MPa, internal design pressure = 10 MPa. C) Discuss Lockhart Martinelli and Baker's Method for two phase pressure drop calculation.	(5) (5) (10)	3	4
Q5	A) Build a data sheet for a carbon steel gate valve. Size is 20" and fluid flowing is cooling water at 20 deg C. B) Analyze difference between API 600 and API 6D C) Discuss inverted bucket and bellows type steam traps. D) Analyze the various constructional features of ball valves	(5) (5) (5) (5)	2	5
Q6	A) Determine whether flexibility analysis is required for the pipe loop operating at 300 deg C. Installation temperature is 30 deg C and pipe OD is 273 mm.  B) Find the span of ASTM A 106 Gr. B pipe of OD 114, thickness of 6 mm and having a uniform load of 160 N/m. Limit the deflection to 6 mm. E=200 GPa C) Discuss rigid supports and pipe hangers. D) Discuss steps in support design	(5) (5) (5) (5)	3	6
Q7	Discuss the below with neat sketches A) Heat exchanger piping (show two sketches) B) Tank farm piping (show any two sketches) C) Reactor piping (show any two sketches) D) Distillation column piping	 (5) (5) (5) (5)	3	7
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Bharatiya Vidya Bhavan's

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END SEMESTER EXAMINATION
May 2018

Date: 21/05/2018
Program: M.Tech. (Mechanical) Thermal Engineering **Duration: 3 hrs.**
Course code: MTTH211 **Max. Marks: 100**
Name of the Course: Air-Conditioning System Design **Semester: II**
Instructions:

- **Question 1 is compulsory.** Attempt any **FOUR** questions **out of SIX.**
- Make any suitable assumption if needed.
- Draw neat diagrams where ever necessary.
- Answer to all sub questions should be grouped together.
- Use of refrigeration tables, steam table and phychrometric chart is permitted.

Q. No		Mark	CO No.	M. No.
Q1	a) Describe briefly Humidity Control in air-conditioning system.	05	01	06
	b) Explain what is evaporative cooling and also explain why evaporative cooling need not create comfort conditions.	05	02	04
	c) Discuss differences and features of Window type AC, Package type AC & Split AC systems with their relative applications.	10	02	04
Q2	A cold storage is to be designed to store 500 tonnes of vegetables when the following data are available : Outdoor conditions = 35°C DBT; 28°C WBT Required indoor conditions = 20°C DBT; 60% RH, Water contents of the vegetables = 76%, loss of water content = 0.01% per hour, People working in the cold storage = 25, Fresh air supplied from outside = 4400 m^3/h, Sensible heat gain through glass = 5.8 kW, Sensible heat gain through walls and ceilings = 11.6 kW, Heat from equipment & reaction heat of vegetables = 3.5 kW, Infiltrated air = 200 m^3/h, If the air conditioning is achieved by first cooling and dehumidifying and then heating, find the following : (a) Amount of recirculated air, if the recirculated air is mixed with fresh air before entering the cooling coil, (b) Capacity of the cooling coil in tonnes of refrigeration and its by-pass factor if dew point temperature of the coil is 5°C, (c) Capacity of the heating coil in kW. The temperature of the air entering the room is not to exceed 15° C.	20	01, 02, 04	01

Q3 Explain in detail with neat sketch any **TWO** of the following:

i. Aircraft air-conditioning
ii. Marine air-conditioning
iii. Railway air-conditioning

20	01	07

Q4 A room for process work is maintained at 20° C DBT and 25 % RH. The outside air is at 40°C DB and 25.0 WB temperatures. 12 cmm of fresh air is mixed with a part of recirculated air and passed over the absorption dehumidifier. It is then mixed with another part of recirculated air and is sensibly cooled in a cooler before being supplied to the room at 14°C. The room sensible and latent heat gains are 6.0 and 0.8 kW respectively.

Entering Moisture Content, g/kg d.a.	2.86	4.29	5.7	7.15	8.7	10.0	11.43	12.86	14.29
Leaving Moisture Content, g/kg d.a.	0.43	0.57	1.0	1.57	2.15	2.86	3.57	4.57	5.23

Calculate the volume flow rate of the air entering the dehumidifier and the amount of heat removed in the cooler. The performance of the absorbent material is as shown in table. The heat of adsorption may be taken as 390 kJ/kg of the moisture adsorbed.

20	03, 04	02

Q5 a) An air conditioning system has volume flow rate of 7.5 m^3/s and fan outlet velocity is 10 m/s. The duct has four branches with 90° elbows. The first branch is 10 m from fan. The distance between branches is 10 m and the main duct has 90° elbow 10m after the fowl branch. The volume flow rate in each branch is 1.5 m^3/s. The main duct runs 10 m after the 90° bend.

i. Using equal friction method, determine the equivalent diameter of duct and dimensions of rectangular duct if one side of the duct is 0.5 m.

ii. Determine the total pressure drop. Given:

$$\frac{p_f}{L} = \frac{0.002268\,(Q)^{1.852}}{(D)^{4.973}}\ mm\ of\ water\ ; \quad p_v = \left(\frac{V}{4.04}\right)^2\ mm\ of\ water$$

$$D = \frac{1.3\,(ab)^{0.625}}{(a=b)^{0.25}}\ ; \quad \text{Elbow loss} = 0.25\, p_v$$

Fitting losses = 0.25 x Difference of velocity pressures
Dynamic loss in branch = 0.2 p_v + Elbow loss

15	04	05

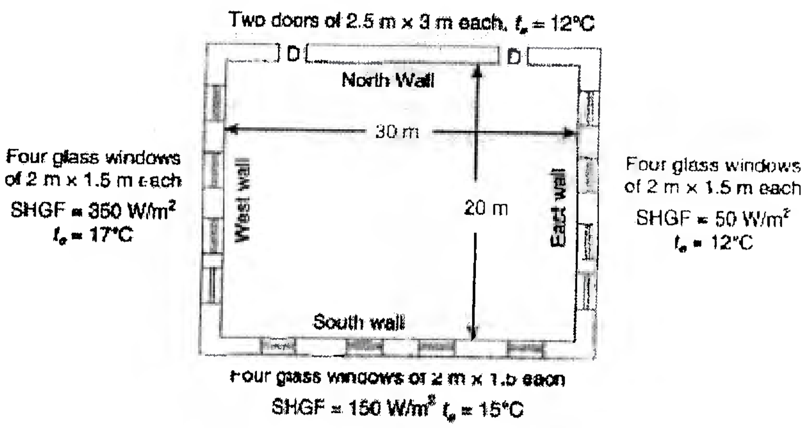
b) Describe Equal friction method and static regain method in duct design.

05	01	05

Q6 a) A laboratory 30 in x 20 m x 4 m high is to be air conditioned. The 30 m wall faces north. The north wall has two doors of 2.5 m x 3 m each. The south wall has four glass windows of 2 m x 1.5 m each. The east and west walls also have four windows of the same size. The lighting load is 15 W fluorescent per m^2 floor area. The infiltration is one air change. The solar heat gain factors (SHGF) for south, east and west glass are 150, 50 and 350 W/m^2 respectively. The overall heat transfer

15	04	02

coefficients for walls, roof, floor, door and windows are 2.5, 2, 3, 1.5 and 6 W/m^{2}K respectively. The corrected equivalent temperature differences for north, south, east, west walls, roof and floor are 12, 15, 12, 17, 20 and 2.5°C respectively. There are 100 persons with sensible and latent heat loads of 75W and 55W each respectively. The ventilation requirement is 0.3 m^3/min/person. The outdoor condition is 43°C dry bulb temperature and 0.0277 kg /kg of dry air of humidity ratio. The indoor condition is 25°C dry bulb temperature and 0.01 kg /kg of dry air of humidity ratio. Use a factor of 1.25 for fluorescent light.



Determine room sensible heat load and room latent heat load with 5% safety factor, 5% for fan power, 1% leakage of supply air and 0.5% heat leakage to supply air duct.

	b) Explain the significance of CLF and CLTD method of cooling load calculations.	**05**	**01**	**02**
Q7	**a)** 0.472 m^3/s of air is cooled from 21.1°C DBT and 12.8°C WBT to 12.8°C DBT and 12.2°C WBT. Design a suitable **DX Cooling Coil.** Select 1.5875 cm OD tubes at 3.81 cm centres staggered & 0.71 mm wall thickness. The total fin side surface area per row is 22 m^2 for each m^2 of face area. The inside surface area per row is 1.2 m^2 for each m^2 of face area. The resistance of the metal wall is 0.0044 m^{2}K/W. The face velocity is 2.4 m/s. external heat transfer coefficient is 116.53 W/m^{2}K & boiling heat transfer coefficient is 1704 W/m^{2}K.	**10**	**03**	**04**
	b) Write short note on **any two** of the following: i. Temperature control ii. Noise control iii. Piping system iv. Fan selection and rating	**10**	**01**	06