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24/11/14

M. E (Mech) with Thermal Engg. Sem I

BHARATIYA VIDYA BHAVAN'S
SARDAR PATEL COLLEGE OF ENGINEERING
[An Autonomous Institution Affiliated to University of Mumbai]
End SEM EXAMINATION, NOV 2014

Master
24/11/14

ME (Thermal. Engg). Sem - I

SEM / CLASS: SEM I/ M. E. (THERMAL ENGG.) **TOTAL MARKS: 100**
SUB: Advanced Combustion Techniques **TIME: 04 HRS**

- 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.
- Draw the suitable sketches wherever necessary.

Q1. Solve any Four questions from following: **[20]**

1. What are the fundamental aspects of combustion? Why is it important even today?
2. Discuss the design procedure of liquid fuel combustor.
3. What do we burn fuel and why? Why are we interested in flame speed?
4. What are the most common gaseous fuels used in combustion system (at least four)? State the properties of such fuels.
5. Define Auto-ignition temp and Flash point of fuels. State the values of Flash point Auto-ignition temp of gasoline and diesel fuels.

Q. 2. Answer the following questions. **[20]**

(A) A fuel contains by mass 88%C, 8%H2, 1%S and 3% Ash (Silica). Calculate the Stoichiometric Air. If the air supplied is 20% more than stoichiometric value, find the analysis of the dry products by mass.

(B) In a stoichiometric propane and air flame nitrogen is replaced by helium, whose original burning velocity is 45 cm/sec. Estimate the laminar burning velocity of this new stoichiometric mixture.

Q. 3. Answer the following questions. **[20]**

(A) What are the different types of flames observed in the combustion systems? Explain each flame with neat sketches and with proper uses.

(B) A kitchen room of size 4m x 3m x 3m at 0.1 MPa and 298 K is filled with propane due to leakage from propane gas cylinder of volume 0.1 m^3 initially at 0.5 MPa. Assuming that the leakage stops when the pressure in cylinder reaches 0.1 MPa, determine whether the mixer in kitchen is flammable or not? Consider LFL% and UFL% as 2.1 and 9.1 respectively.

ME (Thermal Engg), Sem-I, Adv. Combustion techniques.

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Q.4. Answer the following questions. [20]

(A) A laminar butane gas jet issued from a tube into the air has a flame height of 10 cm. Determine volumetric fuel flow rate and heat release rate. If the fuel tube diameter is increased by 25% and velocity is decreased by 25%, what will be the flame height? Take heat of combustion of butane gas = 45 MJ/kg and adiabatic flame temperature $T_{ad} = 2300K$.

(B) Explain Laminar Flame Theory with assumptions.

Q.5. Answer the following questions. [20]

(A) What are the major constituents of pollutants emitted by combustion systems? How does emissions from the combustion system affect human health?

(B) Explain a simplified analysis for quenching diameter with schematic diagram. Derive the Equation: MIE $= \frac{128\,\pi}{27}\,\frac{C\,(T_F - T_u)}{{S_L}^3}\,\alpha^2\,K_g$ which is used to calculate minimum ignition energy.

Q.6. Answer the following questions. [20]

(A) The gasoline (represent by C_8H_{18}) is burnt with dry air. The volumetric analysis of products on dry basis is CO_2 = 10.02%, O_2 = 5.62%, CO = 0.88% and N_2= 83.48%.
Determine: (a) A/F ratio (b) equivalence ratio and (c) % stoichiometric air used.

(B) Describe how the combustion system works. Discuss the design concept of C I engine for diesel combustion. State the important properties of liquid fuels and their importance in combustion techniques.

Q.7. Write Short note on following (Any Four) [20]

(a) Burner design factors

(b) Liquid Fuel Combustion

(c) Explain the meaning of perfect, good and incomplete combustion.

(d) Physical processes that govern flammability limit

(e) Three T's of combustion with importance

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ME (Thermal) Sem - I

End Semester Exam

Academic year: 2014-15

MASTER

Class: M.E. Thermal / Sem - I **Total Marks: 100**

Subject: Design & Analysis of Thermal Systems **Time: 4 hrs**

- Attempt any five out of seven questions
- Figures to right indicate full marks
- Assume suitable data if necessary

Q.1 (i) Write Short Notes on: 10

(a) Analysis
(b) Synthesis

(ii) Explain the Characteristics of Thermal Systems with example? 10

Q.2 (i) Explain different aspects of formulation in design? 10

(ii) The pressure drop (Δp) of a fluid in a pipe is a function of pipe diameter D (m), pipe length L (m) as well as fluid density ρ(kg/m^3), and dynamic viscosity μ (kg/m-s) and fluid velocity v (m/s). Obtain non dimensional parameters as function of pressure drop Δp by Buckingham – π theorem. 10

A prototype gate valve which will control the flow in a pipe system conveying paraffin is to be studied in a model. Based on above dimensional analysis a 1/4 scale model is built to determine the pressure drop across the valve with water as the working fluid.

(a) (a) For a particular opening, when the velocity of paraffin in the prototype is 3.0 m s–1 what should be the velocity of water in the model for dynamic similarity?

(The density and viscosity of paraffin are 800 kg/m^3 and 0.002 kg/m-s respectively. Take the kinematic viscosity of water as 1.0 x 10^{-6} m^2/ s).

Q.3 (i) Explain different types of Conceptual Design with example? 10

(ii) Use data from Table 1 at t = 0, 50 and 100°C to establish a second order polynomial that fits h_g to t. Using the equation find h_g at 70 ° C? 10
Determine h_g at 70° C also using Lagrange interpolation method?

Table 1:						
t, °C	0	10	30	50	80	100
h_g , kJ/kg	2501.6	2519.9	2556.4	2592.2	2643.8	2676

Q.4 (i) Write short note on Initial Design? 08

(ii) Give flow chart of design process in thermal system. Explain each step with one example? 12

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Design & Analysis of Thermal System

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Q.5 (i) Write Short Notes on: 8

(a) Bonds
(b) Depreciation

(ii) Three manufacturers bid for a fan for cooling system with the given specifications. The first manufacturer, Fan A, is payable at $64 immediately after delivery. The second manufacturer, Fan B, requires two payments of $30 each at the end of the first and second years of delivery. The last manufacturer, Fan C, requires a payment of $65 at the end of two years after delivery. A total of 1000 fans has to be purchased. Consider three different interest rates of 6, 8 & 10%. Which fan is best to buy and how much will be the total price for all three interest rates. Make Comparative Table? 12

Q.6 (i) Describe the need of Optimization? Give definition of optimization? 8

(ii) An ethylene refining plant receives 400 kg/hr of 50% pure ethylene and refines it into two types of output: 12

1. 90% pure,
2. 70% pure.

Raw material cost is Rs. 40 /kg.

Sr. No.		Type 1 (90% pure)	Type 2 (70% pure)
1.	Selling Price per kg	Rs. 220	Rs. 120
2.	Packaging facilities per hr	200 kg	225 kg
3.	Transportation cost per kg	Rs. 8	Rs. 16

Total transportation cost should not exceed Rs. 4000 per kg.
Maximize the profit subject to all the constraints.

Q.7 (i) Explain any one Search method for optimization? 06

(ii) The cost C per unit mass of material processed in an extrusion facility is given by the expression 06

$$C = 2T^2V + \frac{3T}{V^2} + \frac{2}{T}$$

Where T is the dimensionless temperature of the material being extruded, V is the dimensionless volume flow rate, and C includes both capital and running costs. Determine the minimum cost.

(ii) Consider a Water Heater where a heat produced by electricity is kept in a cylindrical storage tank. The storage tank has a capacity of 4,000 liters & convective losses from the tank have to be minimized. Radiative losses can be neglected. Ambient temperature and convection co-efficient are constant. The hot water temperature T may be assumed constant in the analysis. 08
Solve this problem as constrained problem with two variables by Lagrange Multiplier method.
Comment on sensitivity co-efficient?

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Sardar Patel College of Engineering

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End Semester Examination

November 2014

Course: ME Thermal (Sem I) **Duration: 4 Hours**

Subject: Energy Resources, Conversion and Management **Maximum Marks: 100**

M.E (Mech) with Thermal Engg Sem I Master

1. Attempt any **Five** questions.
2. Answers to all sub questions should be grouped together.
3. Figures to the right indicate full marks.
5. Make suitable assumptions and justify the same.
4. Steam table is allowed.

Q.1 (a) Write comment on India's production and reserves including fossil fuels, water power, nuclear power and miscellaneous sources. **[10]**

(b) Estimate monthly average daily global radiation on a horizontal surface at New Delhi (19° 07' N, 72° 54' E) during the month of March if the average sunshine hours per day is 9.5. Take constants a = 0.25 and b = 0.57 and $H_o = \overline{H_o}$. **[10]**

Q.2 (a) A 5 kg block initially at 350°C is quenched in an insulated tank that contains 100 kg of water at 30°C. Assume that the water that vaporizes during the process condenses back in the tank and the surroundings are at 20°C and 100 kPa. Determine final equilibrium temperature, the exergy of combined system at the initial and the final states, and the wasted work potential during this process. Take C_p for iron and water as 0.45 and 4.18 kJ/kg-K respectively. **[10]**

(b) Explain different ways of exergy transfer. Also explain decrease of exergy principle and exergy destruction **[10]**

Q.3 (a) Consider a steam power plant that operates on an ideal reheat-regenerative Rankine cycle with one open feedwater heater, one closed feedwater heater, and one reheater. Steam enters the turbine at 15 MPa and 600°C and is condensed in the condenser at a pressure of 10 kPa. Some steam is extracted from the turbine at 4 MPa for the closed feedwater heater, and the remaining steam is reheated at the same pressure to 600°C. The extracted steam is completely condensed in the heater and is pumped to 15 MPa before it mixes with the feedwater at the same pressure. Steam for the open feedwater heater is extracted from the low-pressure turbine at a pressure of 0.5 MPa. Determine the fractions of steam extracted from the turbine as well as thermal efficiency of the cycle. **[12]**

(b) What is cogeneration? And explain with neat sketch how the cogeneration plant with adjustable load works. **[08]**

Q.4 (a) How the heat lost in the collector is expressed. Explain different losses taking place in the flat plate collector in detail. **[12]**

(b) Explain biomass gasification process in detail. **[08]**

Q.5 (a) Calculate the energy content of the wind per square meter for the following situation:
Location : Indore
Month : November
Take ρ for air = 1.20 kg/m^3.
Also calculate the actual energy available for a wind machine for which the cut-in speed is 14 km/h, the design speed is 31 km/h and the cut out speed is 90 km/h. The percentage frequency distribution of hourly wind speed is given in the table. **[12]**

Interval	Nov	Interval	Nov	Interval	Nov	Interval	Nov
00	6.9	10-12	6.2	22-24	4.5	34-36	0.3
00-02	5.9	12-14	7.9	24-26	2.9	36-38	0.1
02-04	4.1	14-16	10.4	26-28	1.5		
04-06	4.5	16-18	13.6	28-30	1.1		
06-08	4.7	18-20	12.9	30-32	0.7		
08-10	1.7	20-22	9.7	32-34	0.4		

(b) What is fuel cell? How it is different from a battery? Give essential functions of a fuel cell. **[08]**

Q.6 (a) A propeller wind machine has a rotor diameter of 80 m. It is operating at a location having a wind speed of 35 km/h and rotating at 30 rpm. Calculate theoretically, the power which the machine can extract from the wind if (i) only wake rotation is considered, (ii) both wake rotation and the effects of drag are considered. For part(ii) assume that the value of ε= 0.012. Use following empirical equations:
For wake rotation maximum $C_p = (16/27)*\exp(-0.3538\ \lambda^{-1.2946})$
For wake and drag effects maximum $C_p = (16/27)*[\exp(-0.3538\ \lambda^{-1.2946}) - \varepsilon\lambda]$ **[10]**

(b) Explain principle of energy storage by flywheel in utilities. On what factors does energy storage depend? **[10]**

Q.7 Write short notes on the following. **[20]**

(i) Combined gas-vapour power cycle plant.
(ii) Closed feed water heaters.
(iii) Pumped hydro storage.
(iv) Magneto-hydrodynamic power generation.

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End Exam

Master

Academic year: 2014-15

ME (Thermal), Sem - I
(Mech)

Class: M.E. Thermal **Total Marks: 100**
Subject: Energy Storage Systems **Time: 4 hrs**

- Attempt any five out of seven questions
- Figures to right indicate full marks
- Assume suitable data if necessary

Q.1	(i)	Explain Long Term and Short Term Energy Storage?	10 m
	(ii)	Explain the problem faced in load leveling and give methods to reduce the magnitude of variations in energy demand?	10 m
Q.2	(i)	Explain different types of storage methods required for vehicles?	08 m
	(ii)	Explain working of a fuel cell with diagram? State its advantages and disadvantages	12 m
Q.3	(i)	Define the following terms: a) Thermal Entropy b) Configurational Entropy c) Gibbs Free Energy d) Energy Quality	10 m
	(ii)	Explain the temperature dependence of G, H & S?	10 m
Q.4	(i)	Explain different types of Thermal Energy? Illustrate with examples?	10 m
	(ii)	What is a Phase Change Material? Give different types of Phase Change Materials with examples?	10 m
Q.5	(i)	Write Short Notes on: (a) Storage of Biomass via Animals (b) Storage of Biomass via Synthetic Liquid Fuels	10 m
	(ii)	Define Biomass Efficiency? What are the factors considered for taking biomass as renewable energy storage mechanism?	10 m

ME (Thermal), Sem - I, Energy Storage system - 26/11/14
(Mech)

Q.6	(i)	Design the petrol storage tank for five passenger car with dimensions.	10 m
	(ii)	What is underground gas storage? Explain the components of a gas storage facility.	05 m
	(iii)	Explain in details: Mechanical Energy Storage	05 m
Q.7	(i)	State major types of reactions in the electro-chemical cells?	06 m
	(ii)	Define Following terms: (a) Specific Energy & Power (b) Energy Density and Power Density (c) Charge Capacity	06 m
	(ii)	Differentiate between Li-ion and Lead Acid Batteries?	08 m

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SARDAR PATEL COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to University of Mumbai) Master.

END SEMESTER EXAMINATION, NOVEMBER 2014

Total Marks: 100 M.E (Mech) with Thermal Engg Sem I Duration: 4 Hours

ME (Thermal Engineering) SEM- I **ME 601: TRANSPORT PHENOMENA**

- Attempt any **FIVE** questions out of **seven** questions.
- Answers to all sub questions should be grouped together.
- Make any suitable assumption if needed with proper reasoning.
- Use of Steam Table and HMT data book is permitted.

1. (a) Write mathematical form of Reynolds Transport Equation and explain each term with help of a real life example? Using the equation develop a mathematical to carry out energy analysis of a transient flow system without heat generation. **10**
   (b) Sate the significance and limitations of the first law of thermodynamics with appropriate example. **5**
   (c) A domestic refrigerator is loaded with food and the door closed. During a certain period the machine consumes 1kWh of energy and the internal energy of the system drops by 5000 kJ. Find net heat transfer to for the system. **5**

2. a) Write the statements of second law of thermodynamics. How does it help in thermal analysis of a generic thermal system? Explain your understanding with suitable examples. **10**
   b) A 4-L pressure cooker has an operating pressure of 175 kPa. Initially, one-half of the volume is filled with liquid and the other half with vapor. If it is desired that the pressure cooker not run out of liquid water for 1 h, determine the highest rate of heat transfer allowed. **10**

3. a) What is irreversibility? List down major factors contributing to irreversibility of a thermal system. Derive an expression to calculate irreversibility and also state if any assumption made. **10**
   b) Highlighting all assumptions made, develop governing equation for the following case. **10**
   "Two infinite size parallel plates with a very small gap 'b' filled with a fluid of dynamic viscosity 'μ' are being pulled in opposite direction with constant speed U under steady condition.
   Obtain an expression for velocity profile and develop expressions for i) Flow rate, ii) average velocity, iii) maximum velocity and iv) wall shear stress.

4. a) Using Reynolds Transport equation, develop an equation for exergy transport and apply it to a closed system and an open system. Discuss all the terms involved and their estimation in a thermal system.
   b) Explain following non dimensional terms with their significance
      i) Biot Number
      ii) Fourier Number
      iii) Reynolds Number
      iv) Prandtl Number

5. a) Write boundary layer equation under the assumption proposed by Prandtl. **10**

List all important features; derive a mathematical expression for Von Karmon's Momentum Integral equation. **10**

b) Derive an expression for parabolic velocity profile in boundary layer and use it to find an expression for displacement thickness.
Air moves over a flat plate with a uniform free stream velocity of 10m/s. At a position 15 cm away from the front edge of the plate, what is the boundary layer thickness?

6. a) Discuss following **three** terms: **10**
i) Closure problem in turbulence
ii) Velocity profile of tutbulent flow
iii) Flow separation
iv) Developed and developing flow

b) Consider a wall of thickness't' of conductivity 'k' having volumetric heat generation q' watt/m^3 maintained at temperature T_1 and T_2 at their two faces, conducting heat at steady state. Use differential form of 3D-energy equation develop and expression for temperature distribution. List all assumption made with appropriate reasons. **10**

7 a) What is lumped parameter model of transient heat conduction? Develop appropriate expression for it and interpret the expression with suitable example. **10**
Specify common thermal boundary condition in transient condition and discuss their effect on temperature distribution of a distributed system.
List down the difference between natural and forced convection. How will identify the convection condition of a thermal system.

b) Air at 20°C flows past a 800mm long plate at a velocity of 45 m/s. If the surface of the plate is maintained at 300°C, Determine **10**
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.

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SARDAR PATEL COLLEGE OF ENGINEERING

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RE- EXAMINATION, DECEMBER 2014.

Total Marks: 100 ME (Thermal, Engg), Sem-I, Re-exam Duration: 4 Hours

ME (Thermal Engineering) SEM- I **TRANSPORT PHENOMENA**

Master ①

- Attempt any **FIVE** questions out of **seven** questions.
- Answers to all sub questions should be grouped together.
- Make any suitable assumption if needed with proper reasoning.
- Use of HMT data book is permitted.

1. With sufficient illustration answer the following questions: **20**

   (i) Discuss characteristic features of a turbulent flow.
   (ii) What is the need of thermodynamic laws for the analysis of thermal a system?
   (iii) What is flow separation? Why does it occur?
   (iv) What do you understand by boundary condition? Write about common thermal and flow boundary conditions.
   (v) Define boundary layer. Explain the concept of displacement and momentum thickness.

2. a) Discuss mechanism of convective heat transfer. How is heat transfer coefficient linked to the convection? 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**

   b) Write the differential form of common conservation law applied to a thermal system and explain the meaning of each terms involved there. **10**
   A liquid flows 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. Clearly state all the assumption made reasons.

3. a) Define and Explain the physical meaning of following non-dimensional numbers: **10**
   a. Reynolds number, b. Nusselt number, c. Prandtl number and d. Grashof number

   b) A pressure vessel has a volume of $2.83 m^3$. It contains air at 7 MPa and 65°C. A valve is now opened and highly pressurized air at a rate of 0.455 kg/s and at temperature 144.4°C enters the vessel. Determine the gas pressure and temperature in the vessel after 1 minute of charging. **10**

4 a) What is exergy? Derive an expression to estimate exergy change of a open system. **10**
   Two 5 kg blocks of steel, one at $250^0 C$ the other at $25^0 C$, come in thermal contact. Find the final temperature and the change in entropy of the steel?

   b) Differentiate between developed and developing region for laminar and turbulent flow, **10**

   For a given flow field $\vec{V} = \left(y^2 + 2xz\right)\vec{i} + \left(-2yz + x^2yz\right)\vec{j} + \left(\frac{1}{2}x^2z^2 + x^3y^4\right)\vec{k}$ explain

   (i) Is this flow possible?
   (ii) Is this flow steady or unsteady?

ME(Thermal. Engg), Sem-I, Re-edan, Transport Phenomena.
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(iii)Is it a possible incompressible flow?
(iv) Find an expression for shear stress τ_{xy} and τ_{yz}.

5 a) 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**

b) Liquid water at 200 kPa and 20°C is heated in a chamber by mixing it with superheated steam at 200 kPa and 150°C. Liquid water enters the mixing chamber at a rate of 2.5 kg/s, and the chamber is estimated to lose heat to the surrounding air at 25°C at a rate of 1200 kJ/min. If the mixture leaves the mixing chamber at 200 kPa and 60°C, determine (*a*) the mass flow rate of the superheated steam and (*b*) the rate of entropy generation during this mixing process. **10**

6 a) Explain transient heat conduction with suitable examples. Simplify differential form of energy equation to obtain mathematical model of 2D transient conduction. Listing all assumption made in lumped parameter model analysis derive an expression for temperature distribution. State the condition of validity. **10**

b) Write differential form of energy equation and explain the different terms involved. Simplify the equation for the following cases: **10**

a. Two dimension transient heat conduction
b. One dimension transient heat conduction with heat generation.

The temperature distribution across a copper plate 0.65 m thick heated from one side is given by $T = 70 - 80x + 24x^2$ where T is in K and x is in meters. Calculate the heat flux at x = 0, x = 0.25 m and x = 0.65 m. Thermal conductivity of the material is 386 W/mK.

7 Write boundary layer equation under the assumption proposed by Prandtl. What is Von Karmon's Momentum Integral equation? Derive a mathematical expression for it. **20**

Assuming second degree velocity distribution in the boundary layer, determine using the integral momentum equation, the thickness of boundary layer, friction coefficient, displacement and momentum thicknesses.