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F.Y.M.Tech.(Thermal) sem I

Design & Analysis of thermal Systems.

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)
Munshi Nagar, Andheri (West), Mumbai – 400058.
End Semester Exam
November 2015

Max. Marks: **100** Duration: **04Hrs**
Class: **F.Y. M. Tech (Thermal Engineering)** Semester: **I**
Program: **M. Tech Mechanical (Thermal Engineering)**
Name of the Course: **Design and Analysis of Thermal Systems**
Course Code : **MTTH103**

Instructions:

1. **Question No 1 is compulsory.**
2. **Attempt any four questions out of remaining six.**
3. **Draw neat diagrams**
4. **Assume suitable data if necessary**
5. **Use of steam property table is permitted**

Master file.

Question No		Max. Marks
Q1(a)	As a Mechanical Engineer with specialization in Thermal Engineering, you are asked to design an engine cooling system. The system should be capable of removing 15 kW of energy from the engine of the car at a speed of 80 km/h and ambient temperature of 35°C. The system consists of the radiator, fan, and flow arrangement. The dimensions of the engine are given. The distance between the engine of the car and the radiator must not exceed 2.0 m and the dimensions of the radiator must not exceed 0.5 m x 0.5 m x 0.1 m. (i) Give the formulation of the design problem. No explanations are needed. (ii) Give a possible conceptual design. (iii) If you are allowed two sensors for safety and control, what sensors would you use and where would you locate these?	(06)
(b)	The objective function U, which represents the cost of a fan and duct system, is given in terms of the design variables x and y, where x represents the fan capacity and y the duct length, as $U=\frac{x^2}{6}+\frac{4}{xy}+3y$ Both x and y are real and positive. Using the univariate search, estimate the optimum (minimum) value of U and the corresponding values of x and y.	(07)
(c)	Calculate the resulting sum F for an investment of Rs100 after 5 and 10 years at a nominal interest rate of 10%, using simple interest as well as monthly, and continuous compounding. From these results, calculate the effective interest rates over 5 and 10 years.	(07)
Q2(a)	One of the proposed smart cities in India is interested in developing a 25 MW power plant, using the burning of waste material for heat input and a local river for heat rejection. It is found that temperatures as high as 400°C can be attained by this heat source, and typical temperatures in the river in the summer are around 35°C. Obtain a simple initial design for such a power plant.	(10)
(b)	Suppose a simple counterflow heat exchanger, as shown in Figure 1 (a), is to be designed. The design variables are the two outer diameters D_1 and D_2 of the inner and outer tubes, respectively; the two wall thicknesses t_1 and t_2; and the	(10)

F.Y. M.Tech. (Thermal) Sem I·
Design & Analysis of thermal systems · DJ · 24/11/15

length L of the heat exchanger. The operating conditions are the inlet temperatures $T_{1,i}$, $T_{2,i}$ and the mass flow rates m_1, m_2, of the two corresponding fluid streams. Let us assume that a mathematical and numerical model has been developed for this system, allowing the calculation of the heat transfer rates and temperature distributions in the two fluid streams, as sketched in Figure 1 (b). Let us take the heat transfer rate Q and the outlet temperature $T_{2,o}$ of the outer fluid stream as the outputs from the model and the remaining variables as inputs. Formulate these quantities in terms of the design variables and the operating conditions, for given fluids.

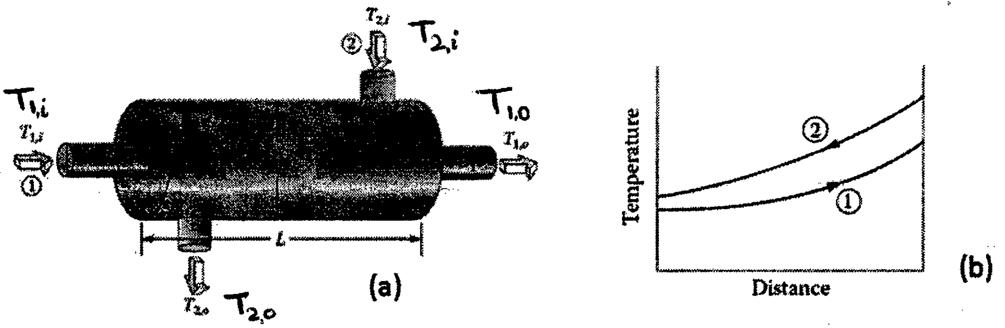

Figure 1: Counterflow heat exchanger

Q3(a) **(10)**

The flow rate Q in circular pipes is measured as a function of the diameter D and the pressure difference Δp. The data obtained for the flow rate in m^3/s are

D (m) → Δp ↓	**0.3**	**0.5**	**1**	**1.4**
0.5	0.13	0.43	2.1	4.55
0.9	0.25	0.81	4	8.69
1.2	0.34	1.12	5.5	11.92
1.8	0.54	1.74	8.59	18.63

Estimate a best fit to these data, assuming a power-law dependence of Q on the two independent variables D and Δp.

(b) **(10)**

Let us consider the steady-state conduction in a solid rectangular bar of length L, height H, and width W. Let us also assume that the thermal boundary conditions are uniform, though different, on each of the six surfaces of the solid and thermal conductivity is constant and no heat source exists in the material. Write governing equation for temperature distribution and also represent the same in non-dimensional form for similar type of system.

Q4(a) **(10)**

A hot-water storage system (see Figure 2) consists of a vertical cylindrical tank with its height L to diameter D ratio given as 8, the diameter being 40 cm. The tank is made of 5 mm thick stainless steel. Hot water from a solar energy collection system is discharged into the tank at the top and withdrawn at the bottom for recirculation through the collector system. The tank loses energy to the ambient air at temperature Ta with a convective heat transfer coefficient h at the outer surface of the tank wall. The temperature range in the system may be taken as 20^0 C to 90^0 C. Develop a mathematical model for the storage tank to determine the temperature distribution in the water. Also use nondimensionalization to obtain the governing parameters and represent the mathematic model in nondimensionalize form for steady state condition.

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	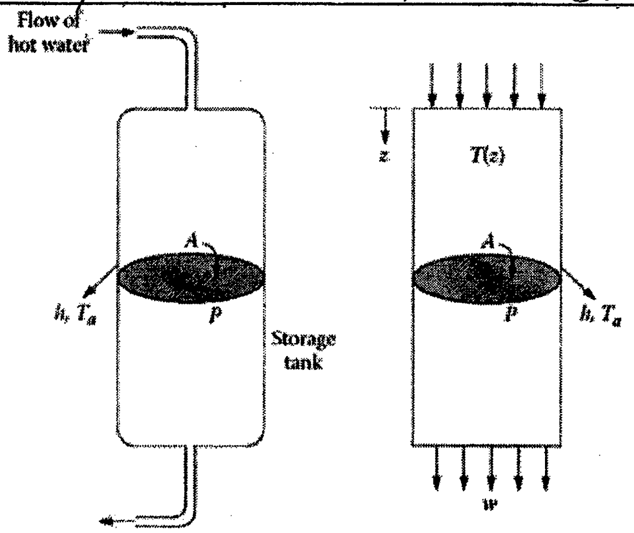 **Figure 2:** Hot Water Storage System.	
(b)	The steady-state temperature T(x) due to conduction in a bar, with convection at the surface and assumption of uniform temperature across any cross-section, is governed by the equation $\frac{d^2\theta}{dx^2} - G\theta = 0$ where G is a constant and is given as 50.41 m^{-2}. Here, θ is the temperature difference from the ambient, which is at 20^0 C. The bar, which is 30 cm long, is discretized such that $\Delta x = 6$ cm and $x = i\Delta x$, where i = 0, 1,2, ….. , 5. It is given that the temperatures at the two ends, θ_0 and θ_5, are 100^0C. Represent the matrix based on nodal equations to determine temperature at nodes 0, 1…..5.	(10)
Q5(a)	The motion of a stone thrown vertically at velocity V from the ground at x = 0 and at time t=0 is governed by the differential equation $\frac{d^2x}{dt^2} = -g - 0.1\left(\frac{dx}{dt}\right)^2$ where g is the magnitude of gravitational acceleration, given as 9.8 m/s^2, and the velocity is dx/dt, also denoted by V. Solve this equation to obtain velocity V as functions of time using Runge Kutta method. Take the initial velocity V as 25 m/s. Further take step size of time as 0.3 sec for total time duration of 1.2 sec.	(10)
(b)	The design of the cooling system for a personal computer requires a fan. Three different manufacturers are willing to provide a fan with the given specifications. The first one, Fan A, is at Rs 540, payable immediately on delivery. The second one, Fan B, requires two payments of Rs 300 each at the end of the first and second years after delivery. The last one, Fan C, requires a payment of Rs 650 at the end of two years after delivery. Since a large number of fans are to be purchased, the price is an important consideration. Consider three different interest rates, 6, 8, and 10%. Estimate which fan is the best buy?	(10)
Q6(a)	In a food-processing system, the refrigeration and storage unit is to be purchased. A new unit can be obtained by paying Rs100,000 on delivery and 5 annual payments of Rs 25,000 at the end of each year, starting at the end of the first year. A used and refurbished unit can be obtained by paying Rs 60,000 at delivery and 10 annual payments of Rs 20,000 at the end of each year. The salvage value of the new unit is Rs 75,000 and that of the used one is Rs 50,000, both being disposed of at the end of 10 years. The interest rate is 9%, compounded annually. Estimate which alternative is financially more attractive?	(10)
(b)	The objective function for an optimization problem is taken as the total income, which involves an income of five units on item A and seven units on item B.	(10)

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The former requires 2.5 hours of cutting and 1.5 hours of polishing, whereas item B requires 4 hours of cutting and 1 hour of polishing. If the total labor hours available for cutting are 4000 and for polishing 2000, formulate the optimization problem and solve it by the simplex method to obtain the optimum.

Q7(a) Consider the convective heat transfer from a spherical reactor of diameter D and temperature Ts to a fluid at temperature Ta, with a convective heat transfer coefficient h. Denoting (Ts – Ta) as θ, h is given by **(10)**

$$h = 2 + 0.55\theta^{0.27} D^{-1.2}$$

Also, a constraint arises from strength considerations and is given by $D\theta = 75$

It is desired to minimize the heat transfer from the sphere. Set up the objective function in terms of D and θ and with one constraint. Employing Lagrange multipliers for this constrained optimization, evaluate the optimal values of D and θ

(b) Use dynamic programming to identify the path for minimum cost of transportation from point A to B in Figure 3 below while passing through one of the three stations of locations C, D, and E. Employ the costs given in the Figure 3 and the following costs for going between the other locations: **(10)**

1–1	1–2	1–3	2–1	2–2	2–3	3–1	3–2	3–3
10	14	20	14	15	16	20	16	15

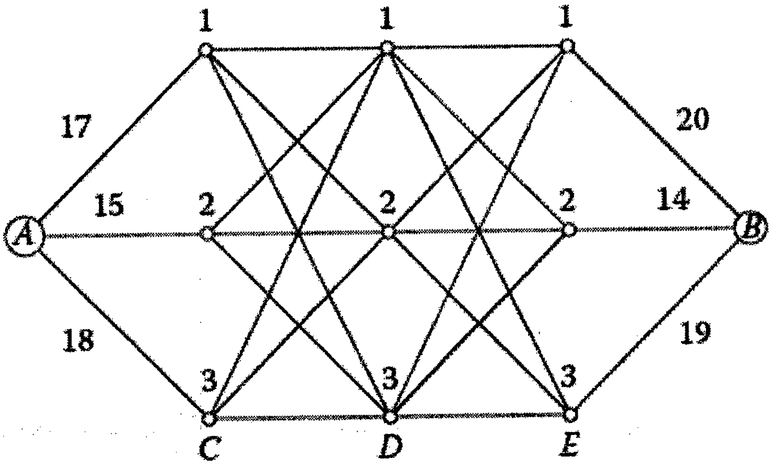

Figure 3: Different paths from point A to B

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M.Tech (Thermal Engg.) sem I ·
Advanced combustion

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)
Munshi Nagar, Andheri (West), Mumbai – 400058.
End Semester Exam
November 2015

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Max. Marks: 100
Duration: **4 Hrs.**
Class: **M. Tech.**
Semester: **I**
Program: **Thermal Engineering**
Name of the Course: **Advanced Combustion Technique**
Course Code : **MTTH 112**

Instructions:

1. **Question No 1 is compulsory.**
2. Attempt any four questions out of remaining six.
3. Draw neat diagrams
4. Assume suitable data if necessary

Q1. Answer the following questions (Any Five) **20**

(a) What are the methods available to measure Laminar burning velocity?

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

(c) What do you mean by diffusion flame? How is it different from premixed flame?

(d) What do you mean by flame stabilization? What do you mean by Break Point of flame height?

(e) Discuss the design procedure of liquid fuel combustor.

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

Q2. (A) 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. **10**

(B) Explain a simplified analysis for quenching diameter with schematic diagram. Derive the equation $d_q = \sqrt{8\,C}\;\frac{4}{3}\;\frac{\propto}{S_L}$ which is to calculate quenching diameter. **10**

Q3. (A) Explain Fluidized Bed Furnaces. What are the working principles of Fluidized Bed Furnaces? State its problems and applications. **10**

(B) Methane gas is issued from a tube of 0.5 mm diameter at 298 K and 0.1 MPa. Flow rate of methane gas is 5 LPM. Estimate the flame height by phenomenological analysis assuming the Lewis number equal to one. State the assumptions made. **10**

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Q4. (A) Explain the modeling of Knock of S I Engine combustion using ethane gas as fuel. Consider other parameters which are involved in knocking. State the assumptions made. Consider initial conditions corresponding to compression of a fuel-air mixture from 300 K and 1 atm to TDC for a compression ratio of 10:1. Initial volume before compression is 3.68 x 10^{-4} m^3. Stroke and Bore are equal. Stroke value is 75 mm. **10**

(B) Explain how the flame structure is affected by various factors such as equivalence ratio, initial pressure, initial temperature and type of fuel. **10**

Q5. (A) What are the applications of combustion system modeling? How the modeling of diesel droplet evaporation and burning takes place? How is Reynolds number responsible for droplet burning? **10**

(B) Determine the air-fuel ratio for a 6 cylinder SI Engine at wide open throttle using gasoline (C_8H_{17}) by carbon balance method. Consider exhaust gas compositions as CO_2 = 8.7%, O_2 = 0.3%, CO = 8.9%, H_2 = 3.2%, CH_3 = 0.6%, **10**

Q6 (A) A full propane cylinder from a camp stove leaks its content of 0.464 kg into 3.66 m x 4.27 m x 2.44 m room at 20°C and 1 atm. After a long time, the fuel gas and room air are well mixed. Is the mixture in the room flammable?
Consider propane air mixtures are flammable for $0.51 < \Phi < 2.83$. Assume mixture as ideal gas mixture. **10**

(B) What is the mechanism of soot formation in a diffusion flame? Describe it briefly. **05**

(C) What do you mean by diffusion flame? How is it different from premixed flame? **05**

Q7 Answer the following questions (Any Five) **20**

(b) State the Burner design factors. What are the factors to be considered for burner locations?

(c) What do you understand by homogeneous reaction? How does it differ from heterogeneous reaction?

(d) What is the difference between ultimate analysis and proximate analysis of coal?

(e) Explain Minimum Ignition Energy and Flame quenching.

(f) What is the difference between deflagration and detonation?

(g) Explain about Scope of combustion in details.

(h) Under what condition one can produce under-ventilated and over-ventilated diffusion flame?

M.Tech. (Thermal) sem I.
Energy storage systems.

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)
Munshi Nagar, Andheri (West), Mumbai – 400058.
End Semester Exam
November 2015

Max. Marks: 100
Class:M.Tech Thermal Engineering
Program: MTech(Thermal Engineering)
Name of the Course: **Energy Storage Systems (Elective II)**
Instructions:.

Duration: 4 Hours
Semester: I
Course Code : MTTH114

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1. Question No 1 is compulsory.
2. Attempt any four questions out of remaining six.
3. Draw neat diagrams.
4. Assume suitable data if necessary.

Question No		Maximum Marks
Q1(a)	How the quality of energy produced is important. On what factor does it depend?	05
(b)	How capacitors can be used to store energy. Explain it with neat sketch.	05
(c)	Discuss potential energy storage using gravity.	05
(d)	Discuss the use of hydrogen as a fuel in different systems.	05
Q2(a)	Explain the method that can be used to reduce magnitude of variation in energy demand	10
(b)	Explain in detail long term or seasonal storage, daily and weekly storage methods.	05
(c)	Describe the method of storage used for portable electronic devices.	05
Q3(a)	What is energy available to do work for chemical reactions? Explain the temperature dependence of Gibbs free energy, enthalpy and entropy.	10
(b)	Explain thermal entropy and configurational entropy in the perspective of energy storage devices.	10
Q4(a)	Explain energy storage or transfer by using latent heat and sensible heat methods.	10
(b)	Explain in detail inorganic phase change materials and organic phase change materials giving examples and potential of energy that can be	10

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	harnessed from them.	
Q5(a)	Discuss in detail energy stored in living biomass and animals.	10
(b)	How synthetic liquid fuels are manufactured.	05
(c)	Why some gaseous fuels are stored as liquids. How they are converted into gas and combusted.	05
Q6(a)	Explain energy storage by using flywheel in detail by discussing the aspect of materials used for flywheel and the maximum power that can be extracted from flywheel.	10
(b)	Explain in detail electrostatic energy storage method in electrical double layer in the vicinity of electrolyte or electrode interface.	10
Q7(a)	How the hydrogen can be produced by electrolytic production method explain it in detail.	10
(b)	Explain following reconstitution reaction relevant to electrochemical system i)Formation Reaction ii)Displacement Reaction	10

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M.Tech (Thermal Engg.), Sem - I
Transport Phenomena

BHARATIYA VIDYA BHAVAN'S

SARDAR PATEL COLLEGE OF ENGINEERING

Munshi Nagar,Andheri(West),Mumbai 400 058

(A Government Aided Autonomous Institute)

End Semester Examination, November 2015

M.Tech. (Thermal Engg.), SEM-I **MTTH 101 –TRANSPORT PHENOMENA**

Duration: **4 Hour** Max Marks: **100**

Instructions:

- Answer any **five** (05) questions.
- Figure to the right of questions indicate full marks.
- Make suitable assumption if required.
- Answers to all sub-questions should be grouped together.
- Use of steam table and HMT data book is permitted.

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1. a) Explain significance of the boundary layer theory in context to thermal problem. State Von Karmon's approach of boundary layer analysis and drive a mathematical expression to analyze flow over plate with zero pressure gradients in the direction normal to the flow. **08**

b) Air at 300 K and atmospheric pressure enters a tube of diameter 12 cm and length of 1m. The bulk stream velocity within the tube is 3 m/s and the heat flux from the surface of the tube is specified by **12**

$q = q_0 cos^4(2\pi x)$ where $q_0 = 0.5$ kW/m^2. Determine the temperature at outlet.

Also , estimate the local bulk stream temperature T_b , and the surface temperature T_s at x = 0.75m ; Assume the properties of air at 300 K as

$\rho = 1.2$ kg/m^3, $\mu = 1.8 \times 10^{-5}$ kg/ms, Cp= 1.01 kJ/kgK,
k = 0.0262 W/mK, Pr = 0.708

2. a) What is heat transfer coefficient? Discuss its variation in laminar and turbulent region of the flow with proper reasoning. Develop a Nusselt number correlation for a fully developed pipe flow under constant heat flux boundary condition. **08**

b) What is transient conduction? State different available model to capture transient thermal effect. **12**

Assume a spherical ball of infinite conductivity suddenly being exposed to an environment at constant high temperature. It is desired to estimate time variation of ball temperature. Analyze the problem and develop an appropriate mathematical expression for it. Use XY plot to illustrate your answer.

3. a) Explain the significance of energy and entropy in thermodynamic system analysis. Prove that they are point function of a thermal system. **08**

b) Define and sate physical significance of following non-dimensional numbers. **12**

(a) Biot number, (b) Reynolds number
(b) Nusselt Number (d) Prandtl Number
(e) Grashof Number (f) Rayleigh Number

4. a) With reference to turbulence in flow discuss following. **08**

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Transport Phenomena Dt. 19\11\15

- i) Effect of turbulence on flow and thermal behavior of a system.
- ii) Features of RANS model
- iii) Reynolds stress
- iv) Closure problem

b) A fully developed laminar film of thickness '*h*' is flowing down on a plane inclined at angle (θ) from horizontal surface. **12**

- (i) List the assumption to investigate the problem
- (ii) Develop governing equation and suggest appropriate boundary condition
- (iii) Solve the equations and develop an expression for velocity profile
- (iv) Using profile equation find expression for – average velocity, maximum velocity, flow rate and wall shear.

5. a) Discuss different modes of mass transfer using a least three examples under different mode. State and explain Fick's law of diffusion. **08**

b) Assume a 2D steady incompressible flow with y component of velocity $v = 2y^2 + 2x - 2y$. Determine a possible x component of velocity. **12**

- i) Represent velocity vector
- ii) Local and convective acceleration at (3,2)
- iii) Expression for all shear stress on different plane assuming Newtonian fluid
- iv) Expression for the vorticity of flow at (3,2).

6. a) Discuss and explain the regimes of turbulent velocity profile. Illustrate your answer with suitable sketches. **10**

b) An oil of specific gravity 0.82 and kinematic viscosity 16×10^{-6} m^2/s flows in a smooth pipe of 8 cm diameter at a rate of 2l/s. Determine whether the flow is laminar or turbulent. Also calculate the velocity at the centre line and the velocity at a radius of 2.5 cm. **10**
What is head loss for a length of 10 m?
~~What will be the entry length? Also determine the wall shear.~~

7 a) Explain following. **10**

- i) First and second law of thermodynamics
- ii) Principle of increase of entropy
- iii) Clausieus Inequality
- iv) Factors effecting irreversibility in thermal system
- v) Exergy of an open system

b) A piston cylinder assembly is attached through a valve to source of air which is flowing in steady state through a pipe. Initially, inside the cylinder the volume is 0.01 m^3, the temperature of air inside is 40°C, and the pressure 1 bar. The valve is then opened to the air supply line which is maintained at 6 bar and 100°C. If the cylinder pressure remains constant, what will be the final equilibrium temperature and how much mass will have entered through the valve in grams, when the cylinder volume reaches 0.02m^3? **10**

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M-Tech Thermal -
Energy Resources Conversion & Mgmt.

Sardar Patel College of Engineering
Department of Mechanical Engineering

MTech Thermal   End Semester   November 2015

Subject: Energy Resources Conversion and Management

Use of Steam Tables and Mollier Diagram is permitted

Answer any 5 questions

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Q1

(a) What is the quantum of Electricity generation in India as of June 2015 (approximate figure) and how is it shared (Percentages) by the different energy resources like Coal, Oil, Natural Gas, Hydro, Nuclear and Renewable Energy? (5)

(b) What are captive power plants? What is the fuel source for these plants? (5)

(c) Electrical Power is sometimes given in kW and sometimes as kVA, what is the difference? Explain with examples (5)

(d) What are the reasons for low value of Per capita energy use in India? What is its relation to HDI (Human Development Index)? (5)

Q2

(a) What is the main difference between Indian coal and Coal imported from Australia? (5)

(b) Explain Ultra Supercritical Generation Technology. Why is it recommended by the National Mission on Enhanced Energy Efficiency? (5)

(c) Show that for a Steam and Gas Combined Cycle plant, the efficiency (η) is given by

$$\eta = \eta_s + \eta_g - \eta_s \eta_g$$

where, η_s is steam cycle efficiency and η_g is gas cycle efficiency (5)

(d) With a neat sketch, explain the principle of working of a Fluidized Bed Boiler. What are its advantages? (5)

Q3

(a) What are Sankey diagrams and Grassmann diagrams? Sketch them for a Cogeneration plant (5)

(b) A steam power plant uses a Rankine cycle with reheat. Steam enters the high pressure turbine at 8MPa and 500°C and leaves at 3MPa. Steam is then reheated at constant pressure to 500°C before it expands to 20kPa in the low pressure turbine. Determine the exergy destruction in each of the processes of the cycle and find second law efficiency of the cycle. Neglect pump work. Assume source temperature of 1800K and sink temperature of 300K. Isentropic efficiency of both HP and LP turbines are 80%. (Use Mollier chart to solve this problem) (15)

Q4

(a) A solar PV array is installed on the terrace (45m width and 50m length) of a building of 15m height. A new building comes up on the South side of the building also of 45m width but 60m in height and touching the old building. Find the area of the PV array that gets shaded on 23rd December at 11hrs LAT. Location of buildings is 19° N latitude

For a horizontal Surface, angle of incidence $\theta = \theta_z$ is given by,
$\cos\theta = \sin\delta \sin\varphi + \cos\delta \cos\varphi \cos\omega$.....where all notations are standard

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Energy Resoursecs. conversion & mgmt.

Solar azimuth angle is given by
$\cos \gamma_s = (\cos \theta_z \sin \varphi - \sin \delta)/ (\sin \theta_z - \cos \varphi)$ (10)

(b) A central receiver solar thermal power plant with storage has 1000 heliostats that have 60 sq.m of reflective surface each. The transmission efficiency between incidence and receiver is 25%. The steam plant efficiency is 30%, both are considered constant during the day. Assume that the solar radiation in that particular month follows a sine curve beginning with zero at +6 hours before noon and ending with zero at -6 hrs after solar noon with a peak of
I_{max}=1kW/sq.m. The plant is operated between +5.5 hrs and -5.5 hrs around solar noon. During this period the power plant supplies a steady load of 2.5 MW.
Calculate
(i) The peak power plant output in MW
(ii) The power plant output at startup in MW
(iii) The total energy output in MWh
(iv) The total energy going to storage (ie. output-load)
Hint: Let the sine curve of the solar radiation be given by
$I = I_{max}$ sine $[(t+6)^* \pi/12]$ (10)

Q5
(a) Give examples of Fissile and Fertile material (5)
(b) Each fission of U235 yields 190MeV of useful energy. Assuming 85% of neutrons absorbed by U235 cause fission. Show that 3.9 kg/day of U235 is needed to produce 3000 MW of thermal power. (1 MeV = 1.6×10^{-13} J) (5)
(c) Discuss the variation of neutron cross section with neutron energy and use it to explain the function of the moderator in a nuclear reactor. (5)
(d) With a neat sketch explain the working of the CANDU type of Nuclear reactor. (5)

Q6
(a) Wind at 1 bar and 27°C has a velocity of 15 m/s measured at the reference height above ground of 9.1m. Calculate:
(i) The power density (in W/m^2) of the wind at the reference height
(ii) The power density at the hub of a 60 m diameter wind turbine 60m above the ground. The velocity at a height 'H' above the ground is given by $V/V_r = (H/Hr)^2$, where V_r and H_r are reference velocity and reference height
(iii) Maximum theoretical power delivered by the turbine (Betz limit is 0.59)
(iv) Attainable power of the turbine generator, if it has an efficiency of 94%. (10)

(b) An Anderson OTEC power plant generates 150 MW net power. It uses ammonia as its working fluid. Generation takes place at 21°C and condensation at 10°C. The turbine efficiency is 80% and turbine generator efficiency is 88%. 14% of the gross output is used for auxiliaries. The temperature rise of the seawater in the evaporator and in the condenser is 4°C. Find Mass flow rate of ammonia, Warm and cold sea water flow rates and plant thermal efficiency. Assume that condition of the ammonia vapor entering the turbine is dry saturated. (10)

Ammonia properties

Sat. temperature °C	Sat. pressure (Bar)	hf (kJ/kg)	hg(kJ/kg)	sf(kJ/kg.K)	sg(kJ/kg.K)
10	6.151	227.7	1454.2	0.8814	5.2141
21	8.85	270.8	1463.2	1.06	5.0843

M.Tech. Thermal - Dt. 21/11/15

Q7 Energy Resourses. conversion & mgmt.

Answer **any 4** of the following

(a) Write a note on the role of Ministry of Environment and Forests in giving clearance for a thermal power project

(b) Explain India's 3 stage nuclear program

(c) From an energy point of view, discuss the need for introducing 2 time zones in India

(d) Concept of net metering

(e) Role of Bureau of Energy Efficiency

(f) Methods of Energy storage in solar applications

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M.Tech. (Thermal Engg) Sem I.
Energy Resources. conversion & Management.

BHARATIYA VIDYA BHAVAN'S

SARDAR PATEL COLLEGE OF ENGINEERING

Munshi Nagar,Andheri(West),Mumbai 400 058

(A Government Aided Autonomous Institute)

Re- Examination, January 2016

M.Tech. (Thermal Engg.), SEM-I

Subject: ENERGY RESOURCES CONVERSION AND MANAGEMENT

Duration: **4 Hour** Max Marks: **100**

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Instructions:

- 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 **Mollier Chart** is permitted.

Q1.

(a) The total electricity generation in India as of June 2015 is 2,74,818 MW and how is it shared among the State, Central and Private sector? (5)

(b) The world total coal reserves are estimated to be approximately 10^{12} tons. The current annual consumption rate is $6.62*10^9$ tons and the consumption of coal increases by 0.85% per year. Estimate the lifetime of this resource (5)

(c) What is tri-generation? What is the difference to cogeneration (5)

(d) Explain what is the HDI (Human Development Index)? (5)

Q2.

(a) What is meant by beneficiation of coal, what are the main drawbacks of Indian coal? (5)

(b) With schematic and cycle diagram, explain Ultra Supercritical Generation Technology. (5)

(c) Derive an expression for the efficiency(η) of a Steam and Gas Combined Cycle plant, in terms of η_s the steam cycle efficiency and η_g the gas cycle efficiency (5)

(d) With a neat sketch, explain the principle of working of a Fluidized Bed Boiler. What are its advantages? (5)

Q3.

(a) Steam enters a turbine at the rate of 8kg/s at a condition of 3MPa and 450°C and exits at 0.2 MPa and 150°C. The steam loses heat to the surrounding air at 100kPa and 25°C at the rate of 300W. Find the actual power output, maximum possible power output, second law efficiency, exergy destroyed and exergy of steam at inlet (8)

(b) A steam power plant uses a Rankine cycle with reheat. Steam enters the high pressure turbine at 10MPa and 500°C and leaves at 5MPa. Steam is then reheated at constant pressure to 500°C before it expands to 20kPa in the low pressure turbine. Determine the exergy destruction in each of the processes of the cycle and find second law efficiency of the cycle. Neglect pump work. Assume source temperature of 1800K and sink temperature of 300K. Isentropic efficiency of both HP and LP turbines are 80%. (Use Mollier chart to solve this problem) (12)

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Q4.

(a) A solar PV array is installed on the terrace (45m width and 50m length) of a building of 15m height. A wind mill of 15m height is set up on the South side of the building at the South East corner Assume that the windmill can be approximated to a cylinder of 3m diameter. Find the area of the PV array that gets shaded on 23rd December at 11hrs LAT. Location of buildings is 19° N latitude

For a horizontal Surface, angle of incidence $\theta = \theta_z$ is given by,

$\cos\theta = \sin\delta \sin\varphi + \cos\delta \cos\varphi \cos\omega$.....where all notations are standard

Solar azimuth angle is given by

$\cos\gamma_s = (\cos\theta_z \sin\varphi - \sin\delta)/(\sin\theta_z - \cos\varphi)$ (10)

(b) A central receiver solar thermal power plant with storage has 1300 heliostats that have 25 sq.m of reflective surface each. The transmission efficiency between incidence and receiver is 25%. The steam plant efficiency is 30%, both are considered constant during the day. Assume that the solar radiation in that particular month follows a sine curve beginning with zero at +6 hours before noon and ending with zero at -6 hrs after solar noon with a peak of I_{max}=1kW/sq.m. The plant is operated between +5.5 hrs and -5.5 hrs around solar noon. During this period the power plant supplies a steady load of 2.5 MW.

Calculate

(i) The peak power plant output in MW

(ii) The power plant output at startup in MW

(iii) The total energy output in MWh

(iv) The total energy going to storage (ie. output-load)

Hint: Let the sine curve of the solar radiation be given by

$I = I_{max}$ sine $[(t+6)^* \pi/12]$ (10)

Q5.

(a) Explain the terms- Fissile and Fertile material. Give examples of each (5)

(b) The half life of ^{231}Pa is 3.25×10^4 years. How much of an initial 10.40 microgram sample remains after 3.25×10^5 years? (5)

(c) Discuss the variation of neutron cross section with neutron energy and use it to explain the function of the moderator in a nuclear reactor. (5)

(d) With a neat sketch explain the working of the BWR type of Nuclear reactor. How does it differ from the CANDU reactor (5)

Q6.

(a) A wind tower measures the velocity of wind at a height 9.1 m to be 12 m/s. Calculate the power density of the wind at this height. A large wind turbine with 48 m diameter is placed at this location. The hub of the turbine is 50 m from the ground. Determine the power density of the wind at the hub. Also determine the maximum power that can be delivered by this turbine at this wind velocity. The wind velocity changes in proportion to the square of the height from the ground (10)

(b) An Anderson OTEC power plant generates 150 MW net power. It uses ammonia as its working fluid. Generation takes place at 21°C and condensation at 10°C. The turbine efficiency is 80% and turbine generator efficiency is 88%. The temperature rise of the seawater in the evaporator and in the condenser is 4°C. Find Mass flow rate of ammonia, Warm and cold sea water flow rates and plant thermal efficiency. Assume that condition of the ammonia vapor entering the turbine is dry saturated. (10)

Ammonia properties

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Sat. temperature °C	Sat. pressure (Bar)	hf (kJ/kg)	hg(kJ/kg)	sf(kJ/kg.K)	sg(kJ/kg.K)
10	6.151	227.7	1454.2	0.8814	5.2141
21	8.85	270.8	1463.2	1.06	5.0843

Q7.

Answer **any four(4)** of the following

(a) Write a note on Sankay and Grassmann diagram

(b) India's energy security

(c) 2 time zones in India can reduce energy demand- True or false, explain

(d) Coal Gasification

(e) Factors affecting market price of energy from Thermal power plants

(f) Use of PCM for energy storage in solar applications

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M.Tech. (Thermal Engg.) Sem I
Transport phenomena.

BHARATIYA VIDYA BHAVAN'S

SARDAR PATEL COLLEGE OF ENGINEERING

Munshi Nagar,Andheri(West),Mumbai 400 058
(A Government Aided Autonomous Institute)
Re- Examination, January 2016

M.Tech. (Thermal Engg.), SEM-I **MTTH 101 –TRANSPORT PHENOMENA**

Duration: **4 Hour** Max Marks: **100**

Instructions:

- Attempt any **FIVE** questions out of **SEVEN** questions.

Master file.

- Answers to all sub questions should be grouped together.
- Make any suitable assumption if needed with proper reasoning.
- Use of **HMT Data Book** and **Steam Table** is permitted.

1. 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**

   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.

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

   b) A pressure vessel has a volume of 2.83m^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**

3. 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: **10**
   Maximum and average velocity, (ii) Volume flow rate, and (iii) Pressure drop

   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**

4. a) What is transient heat conduction? Explain it with suitable examples. Listing all assumption made in lumped parameter model analysis develop a governing equation and **10**

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get a general solution. State the condition of its validity.

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.

5. (a) Write boundary layer equation under the assumption proposed by Prandtl. What is Von Karmon's Momentum Integral equation? Derive a mathematical expression for it. **10**

(b) 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. **10**

6. a) What is meant by exergy? Derive separate mathematical expression for exergy loss calculation for general, (a) closed thermal system, (b) open thermal system. **10**

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 with appropriate reasoning,
(i) Is this flow possible?
(ii) Is this flow steady or unsteady?
(iii) Is it a possible incompressible flow?
(iv) ~~Find an expression for~~ shear stress τ_{xy} and τ_{yz}.

7. Answer any **four (04)** of the following with sufficient illustration: **20**

a. What is the need of thermodynamic laws for the analysis of thermal a system?
b. What do you understand by boundary condition? Write about common thermal and flow boundary conditions.
c. Discuss characteristic features of a turbulent flow.
d. Define boundary layer. Explain the concept of displacement and momentum thickness.
e. What is flow separation? Why does it occur?

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M.Tech. (Thermal Engg) sem I.
Advanced combustion Technique.

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)
Munshi Nagar, Andheri (West), Mumbai – 400058.
Re- Exam **Jan 2016**

Duration: **4 Hrs.**

Max. Marks: 100

Class: **M. Tech.** Semester: I

Program: **Thermal Engineering**

Course Code : **MTTH 112**

Name of the Course: **Advanced Combustion Technique**

Master file.

Instructions:

1. **Question No 1 is compulsory.**
2. Attempt any four questions out of remaining six.
3. Draw neat diagrams
4. · Assume suitable data if necessary

Q1. Answer the following questions (Any Four) 20

(a) What are the important properties require for burning characteristics? Explain at least two.

(b) Why is laminar burning velocity used for the characterization of premixed flame?

(c) Define electronegativity. How is it related to fuel and oxidizer?

(d) What do you mean by adiabatic flame temperature? How can it be estimated?

(e) Define Calorific value, Autoignition temperature Flash point and Pour point of fuel.

Q2. (A) A laminar butane gas jet is issued from a tube into the air has 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 = 45000 kJ/kg and T_{ad} = 2300 K. 10

(B) Explain flame propagation during ignition process with schematic diagram. 10

Derive the equation: $MIE = \frac{128\,\pi}{27}\,\frac{C\,(T_f - T_u)}{S_L^3} \propto^2 K_g$ which is used to calculate minimum ignition energy of combustion.

Q3. (A) What are the working principles of Fluidized Bed Furnaces? 10

Derive the expression for Flame Thickness in terms of laminar burning velocity S_L as

$$\delta_L = \frac{4}{3}\frac{\alpha}{S_L}$$

Where, α = thermal diffusivity of gases and S_L = laminar burning velocity and

δ_L= Flame thickness

(B) Gasoline (C_8H_{18}) is burnt with dry air. The volumetric analysis of products on dry basis is CO2 = 10.02%, O2 = 5.62%, CO = 0.88%, and N2 = 83.48%. 10

Determine: A/F ratio, equivalence ratio and percentage stoichmetric air used

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Q4. (A) Explain the modeling of Combustion and injection of fuel in C I Engine. State the assumptions made. Consider initial conditions corresponding to compression of a fuel-air mixture from 300 K and 1 atm to TDC for a compression ratio of 21:1. Initial volume before compression is 3.68 x 10^{-4} m^3. Stroke and Bore are equal. Stroke value is 75 mm. **10**

(B) What do you mean by laminar flow? How does it differ from turbulent flow? why the maximum burning velocity occurs at slightly rich mixture in case of hydrocarbon air mixture? **10**

Q5. (A) What are the applications of combustion system modeling? Discuss about the physical processes that govern flammability limit. **10**

(B) Determine the air-fuel ratio for a 6 cylinder SI Engine at wide open throttle using gasoline (C_8H_{17}) by carbon balance method. Consider exhaust gas compositions as CO_2 = 8.7%, O_2 = 0.3%, CO = 8.9%, H_2 = 3.2%, CH_3 = 0.6%, **10**

Q6 (A) How to control the flow of gas to the burner? Discuss the basic requirements of diesel fuel. **10**

(B) What are the applications of Fluidized bed combustor? **05**

(C) Explain the effects of Stoichiometry on the laminar flame speed. State the factors on which laminar flame? **05**

Q7 Answer the following questions (Any Four) **20**

(a) What do you mean by quenching, flammability and ignition?

(b) What do you understand by lower and upper limits of flammability?

(c) What do you mean by stoichiometric, lean and rich mixtures?

(d) What are the fundamental aspects of combustion? What are the applications of combustion?

(e) What is spray combustion? What is the utility of spray combustion in designing the liquid fuel combustor?