# **GUJARAT TECHNOLOGICAL UNIVERSITY**

# ME - SEMESTER II (NEW) - • EXAMINATION - SUMMER 2016

Subject Code: 2722111

Date: 31/05/2016

### Subject Name: Design and Optimization of Thermal system Time:10:30 am to 01:00 pm

**Total Marks: 70** 

## Instructions:

- 1. Attempt all questions.
- 2. Make suitable assumptions wherever necessary.
- 3. Figures to the right indicate full marks.
- Q.1 (a) List a typical engineering undertaking to design a particular product from initial 07 to its final implementations and also explain Evaluation and market analysis of product.
  - (b) How do you carry out thermal system analysis? List and briefly explain the 07 characteristics commonly encountered in thermal system.
- Q.2 (a) What are the different ways to communicate the details of final design? Discuss 07 it Briefly.
  - (b) What is objective function for thermal analysis? Explain calculus method for 07 optimization.

#### OR

- (b) What do you understand by constraints for thermal system? Explain search 07 method for optimization.
- Q.3 (a) In the design of a hot water storage system, it is given that steady flow of hot water at 75 °C and a mass flow rate *m* of 113.1 kg/hr enters a long circular pipe of diameter 2 cm, with convective heat loss at the outer surface of the pipe to the ambient medium at 15 °C with a heat transfer coefficient *h* of 100 W/m<sup>2</sup> K. The density  $\rho$ , specific heat at constant pressure  $C_p$ , and thermal conductivity *k* of water are given as 1000 kg/m<sup>3</sup>, 4200 J/kg K and 0.6 W/m K respectively. Develop a simple mathematical model for this process and calculate the water temperature after the flow has traverse 10 m of pipe. Take;  $= 5.5 \times 10^{-7} \text{ m}^2/\text{s}$ ,  $= 1.5 \times 10^{-7} \text{ m}^2/\text{s}$ .
  - (b) Differentiate and discuss about mathematical modeling and numerical modeling. 07

#### OR

Q.3 (a) A large cylindrical gas furnace, 3 m in diameter and 5 m in height, is being simulated for design and optimization. Its outer wall is made of refractory material, covered on the outside with insulation. The wall is 20 cm thick and the insulation is 10 cm thick. The variation of the thermal conductivity k, specific heat at constant pressure Cp, and density of the wall material with temperature represented by best fits to experimental data on properties as

$$k = 2.2 \left(1 + 1.5 \times 10^{-3} \times \Delta T\right)$$
$$C_p = 900 \left(1 + 10^{-4} \times \Delta T\right)$$
$$\rho = 2500 \left(1 + 6 \times 10^{-5} \times \Delta T\right)$$

Where  $\Delta T$  is the temperature difference from the reference temperature of 300 K and all the values are in S. I. units. The temperature difference across the wall is not expected to exceed 200 K. The properties of insulation may be taken as constant. Develop a mathematical model for the time dependent temperature distribution in the wall and in the insulation. Solve the governing equation for the temperature distribution in the idealized steady state circumstance, with the thermal conductivity of the insulation given as 1.0 W/mK, temperature at the

inner surface of the wall as 500 K, and temperature at the outer surface of the insulation as 300 K.

- (b) What do you understand by õcurve fittingö in numerical technique? Explain 07 different approaches to curve fitting.
- Q.4 (a) What is importance of simulation? How do you determine the safety limits for 07 the system?
  - (b) Explain Lagrange multiplier method for unconstrained optimization.

OR

- Q.4 (a) Explain the proof of the Lagrange multiplier method for constrained 07 optimization.
  - (b) What is Genetic Algorithm? How does it help in thermal system optimization? 07
- Q.5 (a) How to affect economic factor in engineering design? Explain the economic 07 aspects in application of thermal system.
  - (b) An industrial bond has a face value of 1000 Rs. and has 6 years to maturity. It pays dividends at the rate of 7.5% twice a year. The current interest rate is 5%, compounded monthly. Calculate the sale price of the bond.

#### OR

- Q.5 (a) What is Taxes? What are the main forms of taxation concern to engineering 07 company?
  - (b) A manufacturing system, which is being designed, needs a laser welding 07 machine. Two machines, A and B, both of which are suitable for the manufacturing process, are being considered.

	А	В
Initial cost	20,000	30,000
Annual maintenance cost	4,000	2,000
Refurbishing cost at end of 3 years	3,000	0
Annual savings	500	1,000
Salvage value	500	3,000

The useful life is 6 years for both machines and the rate of interest is 8%, Compounded annually. Determine which machine is a better acquisition.

\*\*\*\*\*

07