Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME- SEMESTER II– EXAMINATION – SUMMER 2015

Subject Code: 2722111 **Date: 01/06/2015**

Subject Name: Design and Optimization of Thermal System

Time: 2:30 PM – 5:00 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)**	What is engineering design? Differentiate the engineering design versus engineering analysis.	**07**
	(b)	Discuss design problem formulation process in details.	**07**
Q.2	**(a)**	What are the importance of modeling in design of the thermal system? Explain the basic concept of mathematical and physical modeling and also dimensional analysis.	**07**
	(b)	Consider typical thermodynamic systems such as, an internal combustion engine, with the thermodynamic cycle and discuss the development of simple mathematical models for these in order to calculate the energy transport rates and the overall performance.	**07**
		OR	
	(b)	A hot-water storage system consists of a vertical cylindrical tank with its height L to diameter D ratio given as 8, the diameter being 50 cm. The tank is made of 7-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 Hot water from a solar energy collection system is discharged into the tank at the top and withdrawn at the bottom for recirculation through the collector system.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 25°C to 100°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. Then solve the steady-state problem.	**07**
Q.3	**(a)**	Explain merging of different models and discuss about accuracy and validation.	**07**
	(b)	Differentiate between numerical simulation and real system.	**07**
		OR	
Q.3	**(a)**	What is system simulation? What are its importance?	**07**
	(b)	Explain basic concepts of optimization techniques.	**07**
Q.4	**(a)**	List various optimization methods and explain the features of any two methods in brief.	**07**
	(b)	List the search methods based on elimination methods. Discuss the dichotomous search technique in detail.	**07**
		OR	
Q.4	**(a)**	Discuss various types of thermal systems for optimization.	**07**

	(b)	For a heating system, the objective function $U(x)$ is the heat delivered per unit energy consumed. The independent variable x represents the temperature setting and has an initial range of 0 to 8. A maximum in U is desired to operate the system most efficiently. The objective function is given as $U(x) = 7 + 17x - 2x2$. Obtain the optimum using the Fibonacci search method.	**07**
Q.5	**(a)**	Differentiate and discuss the calculation of interest with simple and compound interest.	**07**
	(b)	An engineering firm has to decide whether it should withdraw an investment that pays 9% interest, compounded monthly, and use it on a new product. It would undertake the new product if the real rate of increase in buying power from the current investment is less than 5%. The rate of inflation is given as 3.75%. Calculate the real rate of increase in buying power. Will the company decide to go for the new product? What should the yield from the investment be if the company wants a 6% rate of increase in buying power?	**07**

OR

Q.5	**(a)**	Discuss in brief the economic factors in thermal system design.	**07**
	(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. 50, payable immediately on delivery. The second one, Fan B, requires two payments of Rs. 35 each at the end of the first and second years after delivery. The last one, Fan C, requires a payment of Rs. 70 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 7, 9, and 12%. Which fan is the best buy?	**07**

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