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# MMTP-301(A)

## M.E./M.Tech., III Semester

Examination, November 2018

## Computer Aided Design of Thermal System

**(Elective-I)**

***Time : Three Hours***

***Maximum Marks: 70***

***Note:*** i) Attempt any five questions.

ii) All questions carry equal marks.

iii) Draw neat diagram wherever required.

1. a) An air-conditioning system is to be designed for a residential building. The interior of the building is to be maintained at a temperature of 22 ± 5°C the ambient temperature can go as high as 38°C and the rate of heat dissipated in the house is given as 2.0 kW. The location, geometry, and dimensions of the building are given. Formulate the design problem and give the problem statement.

   b) Explain conceptual design steps in design process.

2. a) What are the main features of computer-aided design.

   b) What are different types of materials available for engineering applications and explain their characteristics.





3. a) Explain different types of models.

   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 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 Hot water from a solar energy collection system is discharged into the tank at the top and withdrawn at the bottom for recirculation through the collector system.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°C to 90°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.

4. Experiments are carried out on a plastic extrusion die to determine the relationship between the mass flow rate $m$ and the pressure difference $P$. We expect the relationship to be of the form $m = AP^n$, where $A$ and $n$ are constants. The measurements yield the mass flow rate $m$ for different pressure differences $P$ as

| m (kg/h) | 12.8 | 15.5 | 17.5 | 19.8 | 22.0 |
|---|---|---|---|---|---|
| P (atm) | 10.0 | 15.0 | 20.0 | 25.0 | 30.0 |

   Obtain a best fit to these data and determine the coefficients $A$ and $n$. Is this a good best fit, or should we consider other functional relationships.

5. a) What are the main steps that may be followed in the numerical modeling of a system.

   b) What are the methods for numerical solution.

6. a) Discuss different types of optimization methods.

   b) A heat pump is being designed to supply 12 kW t residential unit when the ambient temperature approximately 0°C and the interior temperature is 20 Using any appropriate conceptual design, list the des variables, constraints, and requirements. Obtain acceptable design to achieve the given requirements the energy consumption is to be minimized, formul the optimization problem.

7. In a system for providing hot water for industrial use, heating unit has a power input of 150 kW and a ther efficiency of $100(0.2 + 0.045T^{0.5})$, in percent, where $T$ is operating temperature in degrees centigrade. The rate of h loss to the environment, in kW, is represented by expression $0.12T^{1.25}$. Formulate the optimization problen maximize the rate of energy supplied to the industry and ob the optimum by using geometric programming. Also, sc the problem by minimizing the energy loss and show that results obtained are the same as before.

8. The objective function for an optimization problem is take the total income, which involves an income of five units item $A$ and seven units on item $B$. The former requires 2.5 h of cutting and 1.5 hours of polishing, whereas item $B$ req 4 hours of cutting and 1 hour of polishing. If the total ha hours available for cutting are 4000 and for polishing 2 formulate the optimization problem and solve it by the sim algorithm to obtain the optimum.

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