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B.Sc. Engg. CSE 8th Semester — 22 August 2019 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION — **SUMMER SEMESTER, 2018-2019**

DURATION: 1 Hour and 30 Minutes — **FULL MARKS: 75**

CSE 4841: Introduction to Optimization

Programmable calculators are not allowed. Do not write anything on the question paper.

There are **4 (four)** questions. Answer any **3 (three)** of them.

Figures in the right margin indicate marks.

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1. a) Consider a wireless ad hoc network with n stations, where n is an even number. Assume, at any moment, half the stations (denoted as $s_i, i = 1, 2, \dots, n/2$) transmit data to the remaining half of the stations (denoted as $d_j, j = 1, 2, \dots, n/2$), where the i-th station transmits to the j-th station when $i = j$. The power transmitted by the i-th station faces attenuation h_{ij} by the time it reaches the j-th destination. For the j-th destination, the sum of the powers received from all the stations (excepts its transmitter) is considered as interference, i.e., for the j-th destination when $i \neq j$, the received power is considered as interference. For reliable communication, the signal to interference and noise ratio (SINR) for the i-th transmitter must exceed a certain threshold γ_i. The target of the network is to minimize the power transmitted by all stations while maintaining a reliable communication. Formulate the scenario as an optimization problem. Assume noise power of σ^2 for the wireless channel. — 10

   b) The WorldLight Company produces two light fixtures (products 1 and 2) that require both metal frame parts and electrical components. Management wants to determine how many units of each product to produce so as to maximize profit. For each unit of product 1, 1 unit of frame parts and 2 units of electrical components are required. For each unit of product 2, 3 units of frame parts and 2 units of electrical components are required. The company has 200 units of frame parts and 300 units of electrical components. Each unit of product 1 gives a profit of \$1, and each unit of product 2, up to 60 units, gives a profit of \$2. Any excess over 60 units of product 2 brings no profit, so such an excess has been ruled out.

   i. Formulate an optimization problem for this scenario. — 8

   ii. Use the graphical method to solve this problem and to find the resulting total profit. — 7

2. a) Consider the following optimization problem: — 12

minimize

$$f(\boldsymbol{x}) = x_1^2 + 3x_3^2 + 2x_1x_3 + 4x_1 + 6x_2 + 5x_3$$

subject to

$$x_1 + 2x_3 = 3$$
$$4x_1 + 5x_2 = 6$$

Use the method of direct substitution to this problem.

   b) Consider the following optimization problem: — 13

minimize

$$f(\boldsymbol{x}) = \frac{1}{2}(x_1^2 + x_2^2 + x_3^2)$$

subject to

$$x_1 - x_2 = 0$$
$$x_1 + x_2 + x_3 - 1 = 0$$

Find the optimum solution of the above problem by applying the Lagrange multiplier method.

3. A transistor radio company manufactures models A, B and C which have profit contributions of 8, 15 and 25, respectively. The weekly minimum production requirements are 100 for model A, 150 for model B and 75 for model C. Each type of radio requires a certain amount of time for the manufacturing of component parts, for assembling and packing. Specially, a dozen units of model A require three hours of manufacturing, four hours of assembling and one hour of packing. The corresponding figures for a dozen units of model B are 3.5, 5 and 1.5 and for a dozen units of model C are 5, 8 and 3. During the forthcoming week the company has available 150 hours of manufacturing, 200 hours of assembling and 60 hours of packing time.

   a) Formulate a linear programming model for this problem. 8
   b) Solve the LPP by working through the simplex method step by step in tabular form. 11
   c) Identify the basic feasible solutions for the LPP. 6

4. a) Consider the following LP problem: 12

   $Minimize\ Z = 3x_1 + 2x_2 + 4x_3,$

   subject to

   $$2x_1 + x_2 + 3x_3 = 60$$
   $$3x_1 + 3x_2 + 5x_3 \geq 120$$
   $$x_1 \geq 0, \quad x_2 \geq 0, \quad x_3 \geq 0.$$

   Using the two-phase method, work through the simplex tableau step by step to solve the problem.

   b) Consider the following LP problem: 13

   $Maximize \quad Z = x_1 + 2x_2,$

   subject to

   $$x_1 + 3x_2 \leq 8$$
   $$x_1 + x_2 \leq 4$$
   $$x_1 \geq 0, \quad x_2 \geq 0.$$

   Work through the revised simplex method step by step to solve the problem.