**JOMO KENYATTA UNIVERSITY**

**OF**

**AGRICULTURE AND TECHNOLOGY**

**UNIVERSITY EXAMINATION 2017/2018**

**FIRST YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF**

**BACHELOR OF SCIRNCE IN OPERATION RESEARCH**

**STA 2150: FUNDAMENTALS OF OPERATIONS RESEARCH**

**DATE: JANUARY 2018 TIME: 2 HOURS**

**INSTRUCTION TO CANDIDATES:**

1. Answer question ONE (section A) and any other two questions in section B
2. Be neat and show all your workings
3. All questions except question one carry equal marks.

**SECTION A (30 MARKS)**

1. Outline and briefly explain the five principal phases of Operation Research. ( 5 marks)
2. Define the term Linear Programming and outline the four steps followed when formulating a linear programming model mathematically. (6 marks)
3. List the four basic properties of linear programming models (4 marks)
4. A fertilizer company that makes two kinds of fertilizers ,(Hi-ph)and Lo-phosphate (Lo-ph).The manufacture of these fertilizers requires three raw materials called RM 1,RM 2,and RM 3.At present there supply of this raw materials comes from the company’s 0wn quarry that is only able to supply maximum amounts of 1500,1200,500 tons/day respectively, of RM 1,RM 2 and RM 3

Their cost Accounting Department estimates that it is costing the quarry $50,$40 and $60/ton respectively to produce and deliver RM 1,RM 2,and RM 3 at the fertilizer plant.

Also, at the present rates of operation, all other production costs (for labour, power ,water ,maintenance ,depreciation of plant and equipment, floor space, insurance, shipping to the wholesaler, etc.) come to $7/ton to manufacture Hi-ph or Lo-ph and deliver to the market.

The sale prices are $222 and $107 per ton, respectively, for Hi-ph and Lo-ph fertilizers.

The Hi-ph manufacturing process needs as inputs 2 tons RM1 and 1 ton each of RM2 and RM 3 for each ton of Hi-ph manufactured .Similarly, the Lo-ph manufacturing process needs as inputs 1 ton RM 1 and 1 ton of RM 2 for each ton of Lo-ph manufactured. Formulate the relevant linear programme and and using the graphical method, find the product mix that will maximize the company’s profits.(8 marks)

 (e) The department of Commerce and Economics Studies plans to hold seminars on four

 Contemporary topics-leasing, portfolio Management, mergers and Acquisitions and

 Derivatives. These seminars should be held once a week in the afternoons. However,

 Scheduling these seminars (one for each topic and more than one seminar per

 Afternoon) has to be done carefully so that the number of students unable to attend is

 Kept to a minimum. The lecture timetable indicates that the number of students who

Cannot attend a particular seminar on a specific day is as follows:

|  |
| --- |
|  Topic |
|  Day Leasing Portfolio Mergers Derivatives |
|  Management Acquisitions |
|  Monday 50 40 60 20 |
|  Tuesday 40 30 40 30 |
|  Wednesday 60 20 30 20 |
|  Thursday 30 30 20 30 |
|  Friday 10 20 10 30 |
|  |

Find an optimal schedule of the seminars and the total number of students who unfortunately will miss at least one seminar. (7 marks)

**SECTION B (20 MARKS EACH)**

1.
2. State and explain the three main reasons for holding inventory and give reasons why only minimal inventories should be held. (6 marks)
3. Explain four types of customer behavior with respect to queuing system. (4 marks)
4. The details of materials stocked in a company are given below with the unit cost and the annual consumption is shs. Classify the materials in to A class, B class and C class by ABC analysis.

|  |  |  |  |
| --- | --- | --- | --- |
| S.No. | Item code No. | Annual consumption in shs | Unit price in shs |
| 1 | 501 | 30,000 | 10 |
| 2 | 502 | 280,000 | 15 |
| 3 | 503 | 3,000 | 10 |
| 4 | 504 | 110,000 | 5 |
| 5 | 505 | 4,000 | 5 |
| 6 | 506 | 220,000 | 10 |
| 7 | 507 | 15,000 | 5 |
| 8 | 508 | 80,000 | 5 |
| 9 | 509 | 60,000 | 15 |
| 10 | 510 | 80,000 | 10 |

1. List and briefly explain the main tools (models) used in solving various Operation Research problems. (5 marks)
2. The three blood banks in Nairobi County are coordinated through a central office that facilitates blood delivery to four hospitals in the region. The cost in *shs* to ship a standard container of blood from each bank to each hospital is shown in the table below. Also given are the biweekly number of containers available at each bank and the biweekly number of containers of blood needed at each hospital. How many shipments should be made biweekly from each blood bank to each hospital so that total shipment costs are minimized? **TO** (15 marks)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| From  | Hosp. 1 | Hosp .2 | Hosp.3 | Hosp .4 | Supply |
| Bank 1 | 160 | 180 | 220 | 320 | 50 |
| Bank 2 | 240 | 140 | 100 | 160 | 80 |
| Bank 3 | 280 | 200 | 120 | 140 | 120 |
| Demand  | 90 | 70 | 40 | 50 | 280 |

1. In a diet problem, the nutrients are starch, protein and vitamins. The foods are two types of grains. This data is summarized below. (MDR is minimum daily required).

|  |  |  |
| --- | --- | --- |
|  | Nutrient unit /kg of grain type  | MDR of nutrients in units |
| Nutrient  | 1 2 |  |
| starch | 5 7 | 8 |
| Protein | 4 2 | 15 |
| Vitamins | 2 1 | 3 |
| Cost($/kg) of food | 0.60 0.35 |  |

Using the simplex algorithm, find the combination of the two food items that’s should be consumed to provide a balanced diet at minimum costs. (10 marks)

1. A small project is composed of 7 activities whose time estimates in weeks are listed below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Activity  | Predecessors | Optimistic  | Most likely  | Pessimistic  |
| A | - | 1 | 2 | 4 |
| B | - | 5 | 6 | 7 |
| C | - | 2 | 4 | 5 |
| D | A | 1 | 3 | 4 |
| E | C | 4 | 5 | 7 |
| F | A | 3 | 4 | 5 |
| G | B, D, E | 1 | 2 | 3 |

1. Draw the network (2 marks)
2. Calculate the expected project duration and the variance of the project duration based on network analysis. (3 marks)
3. Find the expected project completion time (1 mark)
4. Calculate the probability that the project will be completed on or before a deadline of 10 weeks. (4 marks)