SCHOOL OF ACCOUNTING AND BUSINESS BSc. (APPLIED ACCOUNTING) GENERAL / SPECIAL DEGREE PROGRAMME

## YEAR II SEMESTER II - INTAKE V/VI (GROUP B) END SEMESTER EXAMINATION - AUGUST 2017

## QMT 20330 Operational Research

| Date | $:$ | 4th August 2017 |
| :--- | :--- | :--- |
| Time | $:$ | 5.30 p.m. -8.30 p.m. |
| Duration | $:$ | Three $(03)$ Hours |

## Instructions to Candidates:

- Answer any Five (05) questions.
- All questions carry equal marks.
- The total marks for the paper is 100 .
- Use of scientific calculator is allowed.
- Answers should be written neatly and legibly


## Question No. 01

"A-Z" Bank of Commerce and Industry is a busy bank that has requirements for between 10 and 18 workers depending on the time of day. Lunchtime, from noon to 2 P.M., is usually heaviest. The table below indicates the number of workers needed at various hours that the bank is open.

| Time Period | Number of workers Required |
| :---: | :---: |
| 9 A.M.-10 A.M | 10 |
| 10 A.M.-11 A.M | 12 |
| 11 A.M.-Noon | 14 |
| Noon-1 P.M | 16 |
| 1 P.M.-2 P.M | 18 |
| 2 P.M.-3 P.M | 17 |
| 3 P.M.-4 P.M | 15 |
| 4 P.M.-5 P.M | 10 |

The bank now employs 12 full-time employees, but many people are on its roster of available part-time employees. A part-time employee must be occupied for 4 hours per day but can start at anytime between 9 A.M. and 1 P.M. Part-timers are a fairly inexpensive because no retirement or lunch benefits are provided. Full-timers, on the other hand, work from 9 A.M. to 5 P.M. but are allowed 1 hour for lunch. (Half the full-timers eat at 11 A.M., the other half at noon.) Full-timers thus provide 35 hours per week of productive manpower time. By corporate policy, the bank limits part-time hours to a maximum of $50 \%$ of the day's total requirement. Part-timers earn Rs. 350 per hour (or Rs. 1400 per day) on average, whereas full-timers earn Rs. 2100 per day in salary and benefits on average. The bank would like to set a schedule that would minimize its total manpower costs. It will release 1 or more of its full-time employees if it is profitable to do so.

Using the information given develop the linear programme that represent the above problem
(Total 20 marks)

## Question No. 02

You have Rs. 12 million to invest, and there are three different funds from which to choose. The municipal bond fund has a $7 \%$ return, the local bank's Fixed Deposits have an $8 \%$ return, and the high-risk account has an expected return of $12 \%$ with the objective of minimizing risk, you decide not to invest an amount more than Rs. 2 million in the high-risk account. For tax reasons, you need to invest at least three times as much in the municipal bonds as in the bank FDs. Assuming the year-end yields are as expected,

## Required:

Convert the above problem as a Linear Programming problem and solve it using an appropriate method to find the optimal investment amounts?

## Hint: Develop the Linear programme with two decision variables

(Total 20 marks)

## Question No. 03

In order to ensure optimal health (and thus accurate test results), a lab technician needs to feed the rabbits a daily diet containing a minimum of 24 grams (g) of fat, 36 g of carbohydrates, and 4 g of protein. But the rabbits should be fed no more than five ounces of food a day.

Rather than ordering rabbit food that is custom-blended, it is cheaper to order Food X and Food Y , and blend them for an optimal mix. Food X contains 8 g of fat, 12 g of carbohydrates, and 2 g of protein per ounce, and costs Rs 20 per ounce. Food Y contains 12 g of fat, 12 g of carbohydrates, and 1 g of protein per ounce, at a cost of Rs. 30 per ounce.

## Required:

Develop the Linear programme and solve it to find the optimal blend.

## Question No. 04

You and several friends are about to prepare a lasagna dinner. The tasks to be performed, their immediate predecessors, and their estimated durations are as follows:

| Task | Task Description | Must Precede | Time (min.) |
| :---: | :--- | :---: | :---: |
| $A$ | Buy the mozzarella cheese* | - | 30 |
| $B$ | Slice the mozzarella | $A$ | 5 |
| $C$ | Beat 2 eggs | - | 2 |
| $D$ | Mix eggs and ricotta cheese | $C$ | 3 |
| $E$ | Cut onions and mushrooms | - | 7 |
| $F$ | Cook the tomato sauce | $E$ | 25 |
| $G$ | Boil large quantity of water | - | 15 |
| $H$ | Boil the lasagna noodles | $G$ | 10 |
| $I$ | Drain the lasagna noodles | $H$ | 2 |
| $J$ | Assemble all the ingredients | $I, F, D, B$ | 10 |
| $K$ | Pre-heat the oven | - | 15 |
| $L$ | Bake the lasagna | $J, K$ | 30 |

* There is none in the refrigerator.
i. Construct the project network for preparing this dinner.
ii. Find all the paths and path lengths through this project network. Which one of these paths is a critical path?
iii. Find the earliest start time and earliest finish time for each activity.
iv. Find the latest start time and latest finish time for each activity.
v. Find the slack for each activity. Which one of the paths is a critical path?
vi. Because of a phone call, you were interrupted for 6 minutes when you should have been cutting the onions and mushrooms. By how much will the dinner be delayed? If you use your food processor, which reduces the cutting time from 7 to 2 minutes, will the dinner still be delayed?
(Total 20 marks)


## Question No. 05

The "ZAZ" Aircraft Company is ready to begin a project to develop a new fighter airplane for the Air Force. The company's contract with the Defense ministry calls for project completion within 100 weeks, with penalties imposed for late delivery. The project involves 10 activities (labeled A, B, ... J), where their precedence relationships are shown in the below given project network.

Using the PERT three-estimate approach, the usual three estimates of the duration of each activity have been obtained as given below.

| Activity | Optimistic <br> Estimate <br> (weeks) | Most Likely <br> Estimate <br> (weeks) | Pessimistic <br> Estimate <br> (weeks) |
| :---: | :---: | :---: | :---: |
| $A$ | 28 | 32 | 36 |
| $B$ | 22 | 28 | 32 |
| $C$ | 26 | 36 | 46 |
| $D$ | 14 | 16 | 18 |
| $E$ | 32 | 32 | 32 |
| $F$ | 40 | 52 | 74 |
| $G$ | 12 | 16 | 24 |
| $H$ | 16 | 20 | 26 |
| $I$ | 26 | 34 | 42 |
| $J$ | 12 | 16 | 30 |



## Required:

i. Find the estimate of the mean and variance of the duration of each activity.
ii. Find the critical activities.
iii. Find the approximate probability that the project will finish within 100 weeks.
iv. Is the approximate probability obtained in part (iii) likely to be higher or lower than the true value?
$t=\frac{a+4 m+b}{6}$
$\sigma_{i}=\sqrt{\left(\frac{b-a}{6}\right)^{2}}$
$\sigma=\sqrt{\sum_{\begin{array}{c}\text { critical } \\ \text { activities }\end{array}} \sigma_{i}^{2}}$
(Total 20 marks)

## Question No. 06

"POW" has three electric power plants that supply the needs of four cities. Each power plant can supply the following numbers of kilowatt-hours (kwh) of electricity:

Plant $1-35$ million
Plant 2 - 50 million
Plant 3 - 40 million

The peak power demands in these cities, which occur at the same time (2 P.M.), are as follows (in kwh):

City $1-45$ million
City $2-20$ million
City $3-30$ million
City 4-30 million

The costs of sending 1 million kwh of electricity from a plant to a city depend on the distance the electricity must travel. The table given below summarizes the costs (given in rupees).

|  | To |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| From | City 1 | City 2 | City 3 | City 4 |
| Plant 1 | 08 | 06 | 10 | 09 |
| Plant 2 | 09 | 12 | 13 | 07 |
| Plant 3 | 14 | 09 | 16 | 05 |

## Required:

Using an efficient method find the distribution schedule of power to meet each city's peak power demand at a minimum cost.
(Total 20 marks)

