UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester 6 Examination in Engineering: November 2014

Module Number: IS6313   Module Name: Mathematical Modelling

[Two hours]

[Answer all questions, each question carries five marks]

Q1.

a) Briefly explain the stages of the 'Mathematical Modelling Process'.

[1.0 Mark]

b) Name two problems that might be modeled mathematically. Why do you think mathematics may provide a key to each solution? What is the added value in each case?

[1.5 Marks]

c) A bacteria culture starts with 500 bacteria and grows at a rate proportional to its size. After 1 hour, the number of bacteria increased to 800.

   i.) What is the number of bacteria in 5 hours?
   ii.) How long will it take to reach 20,000 bacteria?

[2.5 Marks]

Q2.

a) Briefly explain the importance of 'Dimensional Analysis' in mathematical modelling of real world problems.   [0.5 Marks]

b) Clearly state the 'Buckingham pi Theorem'.   [1.0 Mark]

c) The sound power (W), from a turbulent jet through a nozzle is believed to depend on the following variables:

   • Jet centerline velocity (V)
   • Nozzle diameter (D)
   • Speed of sound (C)
   • Fluid density (ρ)

The temperature and composition of the fluid in the jet is the same as the ambient fluid.

   i.) Using the Buckingham Pi theorem, find a relation between the sound power and the other parameter(s) of the system.

[2.5 Marks]

   ii.) How would the sound power vary if the nozzle diameter is doubled with all other factors remaining the same?

[1.0 Mark]

Q3.

a) State the advantages and disadvantages (2 each) of 'Graphical Method' used in solving linear programming problems in mathematical modelling.

[1.0 Mark]

b) Briefly discuss what is meant by 'Pivot column' and 'Pivot row' in a simplex tableau.

[0.5 Marks]

c) Your family has a farm of 900 acres and you are planning to grow soy beans, pumpkin, and sweet corn in the planting season. Fertilizer costs per acre are: Rs. 500.00 for soy beans, Rs. 200.00 for pumpkin and Rs. 100.00 for sweet corn. You estimate that each acre of soy beans will require an average of 5 hours of labor per week while tending pumpkin and sweet corn should only require about 2 hours each per week. Based on past yields and current market trends, you estimate a profit of Rs. 300,000.00 for each acre of soy beans, Rs. 200,000.00 for each acre of pumpkin and Rs. 100,000.00 for each acre of sweet corn. You can afford to spend no more than Rs. 300,000.00 on fertilizer and your workers combined are willing to work at least 2000 hours per week. Estimate the number of acres of each crop to be planted to maximize your profit, by using Simplex method.

[3.5 Marks]

Q4.

a) Briefly explain the use of 'Dummy demand point' and 'Dummy supply point' in transportation problems.

[1.0 Marks]

b) A large manufacturing company is closing three of its existing plants and intends to transfer some of its more skilled employees to three plants that will remain open. The number of employees available for transfer from each closing plant is as follows.

Closing Plant	Transferable Employees
1	60
2	105
3	70
Total	235

The following number of employees can be accommodated at the three plants remaining open.

Open Plants	Employees Demanded
A	55
B	80
C	90
Total	225

10 employees available for transfer at closing plant 2 confirmed their early retirement and hence not going to employ at any of the open plants.

Each transferred employee will increase product output per day at each plant as shown in the following table. The company wants to transfer employees so as to ensure the maximum increase in product output.

From	To		
	A	B	C
1	5	8	6
2	11	9	12
3	7	6	10

Find the initial solution using,
    i.) the northwest corner method,
    ii.) the minimum cell cost method,
    iii.) the Vogel's approximation model.

Compute total increase of product output for each initial feasible solution.

[4.0 Marks]