NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

MASTER OF ENGINEERING IN MANUFACTURING ENGINEERING/SYSTEMS AND OPERATIONS MANAGEMENT

Supplementary Examination

COURSE	**:**	**OPERATIONS RESEARCH**
CODE	**:**	**TIE 6130**
DATE	**:**	**AUGUST 2013**
DURATION	**:**	**3 HOURS**

INSTRUCTIONS AND INFORMATION TO CANDIDATE

1. Answer **two questions** from Section A and **two questions** from section B.
2. Each Question carries **25 marks**.
3. This paper contains six **(6)** questions (Three in each section)
4. There are six **(6)** printed pages.

REQUIREMENTS

SECTION A

QUESTION 1

a) What is the physical meaning of slack variables for the following types of constraints? [9]

i. Constraint on the capacity of a machine [3]

ii. Constraint on the size of the market [3]

iii. Constraint on the total expenditure on advertising in various media [3]

b) A manufacturer has two products, both of which are made in two steps by machines A and B. The process times for the two products on the two machines are as follows:

Product	Machine A (Hr)	Machine B (Hr)
1	4	5
2	5	2

For the coming period, Machine A has 100 hours available and machine B has 80 hours available. The contribution for product 1 is $10 per unit, and for product 2 it is $5 per unit. Using the methods of the Simplex Algorithm, formulate and solve the problem for maximum contribution. [16]

QUESTION 2

a) Explain the main characteristics of problems that can be solved by Dynamic Programming. [10]

b) A job shop has four jobs that must be processed on a single machine. The due date and processing time for each job are given in Table Q2 below.

Table Q2 : job Processing Times

	Processing Time (Days)	Due Date (Days from Now)
Job 1	2	4
Job 2	4	14
Job 3	6	10
Job 4	8	16

Use Dynamic programming to determine the order in which the jobs should be done so as to minimize the total lateness of the jobs. (The lateness of a job is simply how long after the job's due date the job is completed). [15]

QUESTION 3

a) Explain typical Operations Research Techniques that can be used in solving problems in the following areas:
   i. Capital Budgeting [3]
   ii. Inventory Planning [3]
   iii. Fraud Prevention [3]

b) OILCO (Pvt) LTD controls two oil fields. Field 1 can produce up to 40 million barrels of oil per day, and field 2 can produce up to 50 million barrels of oil per day. At field 1, it costs $3 to extract and refine a barrel of oil; at field 2, it costs $2 to extract and refine a barrel of oil. OILCO sells oil to two countries: England and Japan. The shipping cost per barrel of oil is shown in Table Q3.

Table Q3 : Shipping Costs per Barrel

	TO	
FROM	England	Japan
Field 1	$1	$2
Field 2	$2	$1

Each day, England is willing to buy up to 40 million barrels of oil (at $6 per barrel), and Japan is willing to buy up to 30 million barrels of oil (at $6.50 per barrel). Use the Transportation Problem Algorithm to establish a plan that would maximize OILCO's profits. [16]

SECTION B

QUESTION 4

A Manufacturing company produces two products. Relevant information for each product is shown in the following Table Q4

Table Q4 Labour hours

	Product 1	Product 2
Labour required	4 hours	2 hours
Contribution to profit	$4	$2

The company has a goal of $48 in profits and incurs a $1 penalty for each dollar it falls short of this goal. A total of 32 hours of labour are available. A $2 penalty is incurred for each hour of overtime (labour over 32 hours) used, and a $1 penalty is incurred for each hour of available labour that is unused. Marketing considerations require that at least 7 units of product 1 be produced and at least 10 units of product 2 be produced. For each unit (of either product) by which production falls short of demand, a penalty of $5 is assessed. Formulate a Goal Programme Model which may be used to minimise the total penalty incurred by the company. [25]

QUESTION 5

(a) Explain 5 instances in which Integer Programming may be the most relevant modelling platform in decision making process. [5]

(b) Five investment projects and their expected returns together with their yearly expenditures (in millions of dollars) are as shown in Table QU 5 below. Develop a Mathematical Model for deciding which of the five projects should be executed over a 3-year planning period. [20]

Table Qu 5 Expenditure and Returns

	Expenditure and Returns			
Project	Year 1	Year 2	Year 3	Returns
1	5	1	8	20
2	4	7	10	40
3	3	9	2	20
4	7	4	1	15
5	8	6	10	30
Available Funds	25	25	25	

QUESTION 6

The PERT network in Figure QU6 describes the activities associated with the introduction of a new computerised manufacturing process at a corporate engineering entity in Bulawayo. The PERT time estimates (in months) for each of the activities of the network are presented on the Table QU6 following.

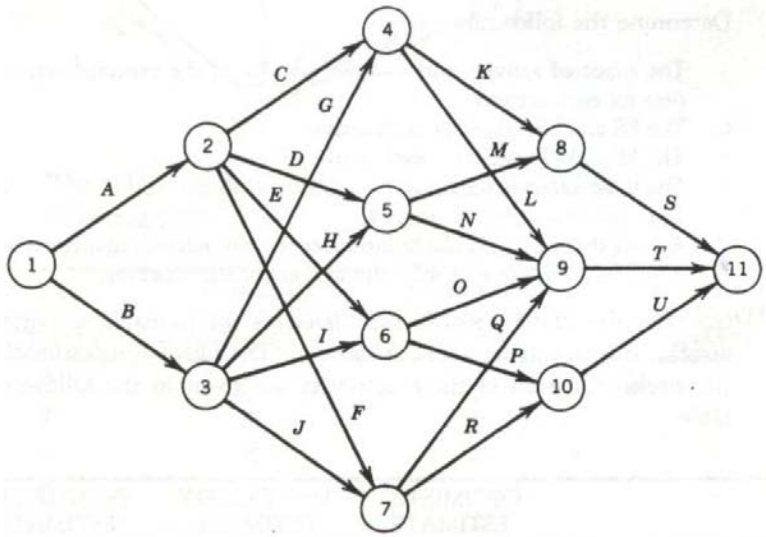

Figure QU6

Table QU6

ACTIVITY	OPTIMISTIC ESTIMATE	MOST LIKELY ESTIMATE	PESSIMISTIC ESTIMATE
A	4	6	10
B	5	6	9
C	6	9	12
D	7	8	11
E	10	10	14
F	9	11	15
G	8	10	14
H	12	13	17
I	9	10	14
J	10	12	15
K	6	7	11
L	4	5	8
M	3	4	7
N	8	9	12
O	9	9	12
P	11	12	17
Q	7	7	13
R	6	9	13
S	8	8	14
T	9	10	15
U	4	5	10

For the project system represented above, determine the following:

(i) The expected activity time and the variance of the expected activity time for each activity [4]
(ii) The ES and LS values for each activity [4]
(iii) The LF and LF values for each activity [4]
(iv) The slack for each activity [3]
(v) The critical path for the project [6]
(vi) Assume that there is need to introducing the new microcomputer within 40 weeks. Will there be difficulty in meeting this deadline? [4]

.....*End of the Examination*.....