

*(Knowledge for Development)*

**KIBABII UNIVERSITY**  
**UNIVERSITY EXAMINATIONS**  
**2016/2017 ACADEMIC YEAR**  
**FOURTH YEAR FIRST SEMESTER**  
**SPECIAL/ SUPPLEMENTARY EXAMINATION**  
**FOR THE DEGREE OF BACHELOR SCIENCE**

**COURSE CODE: MAT 429**

**COURSE TITLE: OPERATION RESEARCH II**

**DATE: 14/09/17**

**TIME: 11.30 AM -1.30 PM**

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**INSTRUCTIONS TO CANDIDATES**

Answer Question One and Any other TWO Questions

TIME: 2 Hours

This Paper Consists of 3 Printed Pages. Please Turn Over.

**QUESTION 1: [30 Marks] (COMPULSORY)**

a) Explain the following terms as used in critical path analysis

- i. Float of an activity and event [1mk]
- ii. Critical path [1mk]
- iii. Free float [1mk]
- iv. Length of critical path [1mk]
- v. Independent float [1mk]

b) Determine an initial feasible solution to the following transportation problem by using the North-west method.

SOURCE	Destination				SUPPLY
	$D_1$	$D_2$	$D_3$	$D_4$	
$S_1$	1	2	1	4	30
$S_2$	3	3	2	1	50
$S_3$	4	2	5	9	20
Demand	20	40	30	10	

[5mks]

c) A corporation is entertaining proposals from its three plants for possible expansion of facilities and is budgeting Shs 5 million for allocation to all three plants as shown in table below

Proposal	Plant 1		Plant 2		Plant 3	
	$C_1$	$R_1$	$C_2$	$R_2$	$C_3$	$R_3$
1	0	0	0	0	0	0
2	1	2	1	5	2	8
3	-	-	2	6	3	9
4	-	-	-	-	4	12

Find the optimal solution using the backward recursive dynamic programming model [8mks]

d) Consider the reliability problem of an electronic device consisting of four main components. The four components are arranged in series so that the failure of one component will cause the failure of the entire device. The total capital is  $C=10$  and the reliabilities  $R_j(k_j)$  and cost  $C_j(k_j)$  for the  $j^{th}$  components ( $j = 1,2,3,4$ ) giving  $k_j$  parallel units are as summarized in the table below;

$k_j$	COMPONENTS							
	1		2		3		4	
	$R_1$	$C_1$	$R_2$	$C_2$	$R_3$	$C_3$	$R_4$	$C_4$
1	0.4	1	0.6	1	0.7	3	0.5	2
2	0.8	3	0.8	2	0.8	5	0.7	4
3	0.95	7	0.9	3	0.9	6	0.9	5

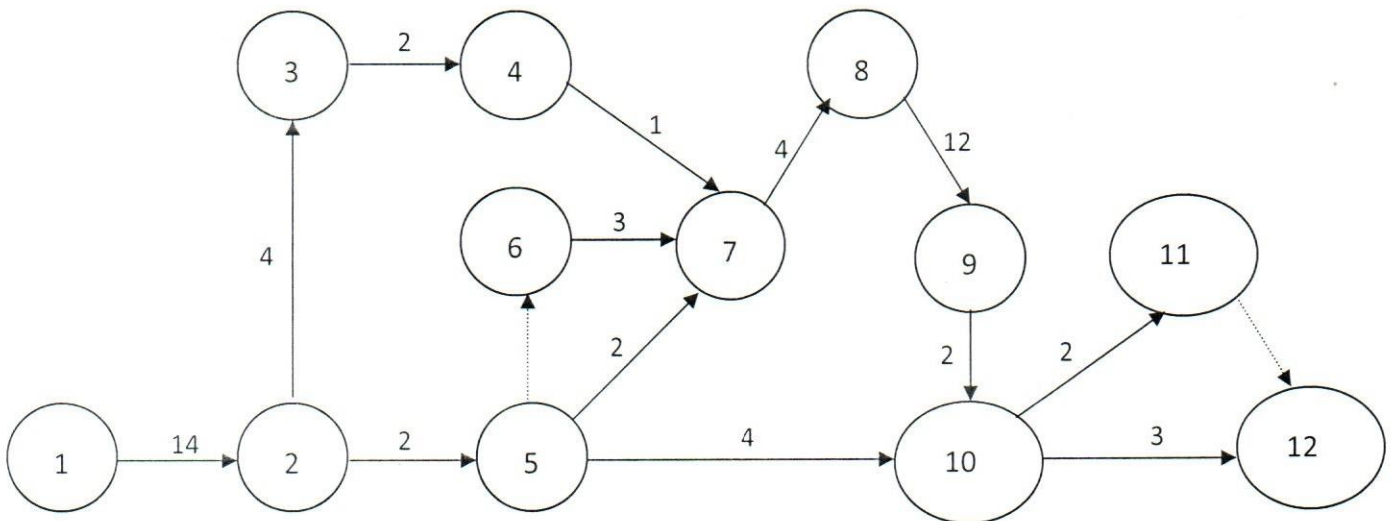
Determine the number of parallel units  $k_j^*$  in component  $j$  that will maximize the reliability of the device without exceeding the total capital C [10mks]

**QUESTION 2: [20marks]**

a) Explain briefly the following as used in the transportation problem

- i. Least cost method [1mk]
- ii. Vogel's approximation method [1mk]
- iii. North-west corner method [1mk]

b) Determine the critical path in the following network that starts at node 1 and terminates at node 12. What is its length?



[8mks]

c) A firm has five workers who have to be allocated to three departments. The return (or profit) from each department depends upon the number of workers working in that department. The expected return for different number of workers in different zones, as estimated from the past records are given below;

Number of workers	Department		
	1	2	3
0	47	32	37
1	60	47	47
2	72	62	54
3	84	72	66
4	95	81	74
5	103	92	84

Determine the optimal allocation policy.

[9mks]

**QUESTION 3: [20marks]**

a) Determine an initial basic feasible solution to the following transportation problem by using

		Distribution center				Supply
		$D_1$	$D_2$	$D_3$	$D_4$	
Plant	$P_1$	2	3	11	7	6
	$P_2$	1	0	6	1	1
	$P_3$	5	8	15	9	10
Demand		7	5	3	2	

i. North –west corner rule

[3mks]

ii. least cost method

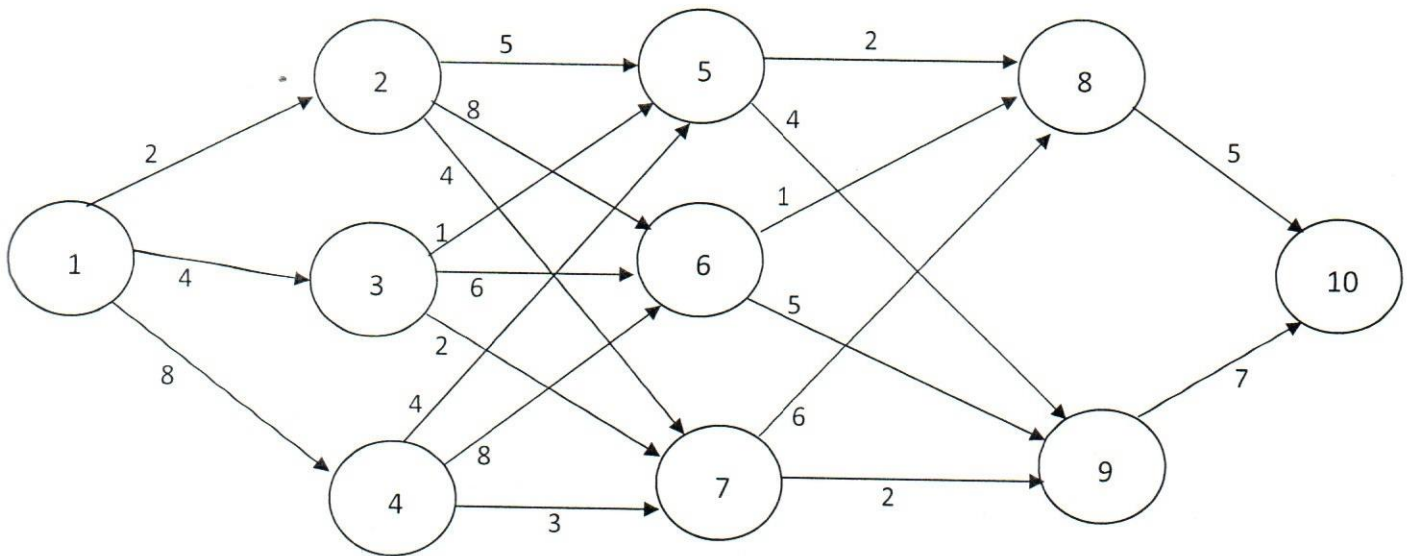
[3mks]

iii. Vogel's approximation method

[4mks]

If the objective is to minimize the total transportation

b) A lorry located in a town 1 decided to travel to town 10. The distances of alternative routes from town 1 to town 10 are given in a highway network map given in the figure below. The arrow representing routes between towns and distances in kilometers are indicated on each route.



Find the shortest route that covers all the selected towns from 1 to 10

[10mks]

**QUESTION 4: [20marks]**

a) Determine an initial basic feasible solution using Vogel's approximation method to the transportation problem shown in the table below

		DESTINATION				SUPPLY
		D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	
SOURCE	S <sub>1</sub>	19	30	50	10	7
	S <sub>2</sub>	70	30	40	60	9
	S <sub>3</sub>	40	8	70	20	18
DEMAND		5	8	7	14	34

[4mks]

- b) An established company had decided to add a new product to its line. It will buy the product from a manufacturing concern, package it, and sell it to a number of distributors selected on a geographical basis. Market research has indicated the volume expected and the size of sales force required. The steps shown in the following table are to be planned

Activity	Description	Duration (days)	Predecessors
A	Organize sales office	6	-
B	Hire salesmen	4	A
C	Train salesmen	7	B
D	Select advertising agency	2	A
E	Plan advertising campaign	4	D
F	Conduct advertising campaign	10	E
G	Design package	2	-
H	Set-up packaging facilities	10	G
I	Package initial stocks	6	J,H
J	Order stock from manufacturer	13	-
K	Select distributors	9	A
L	Sell to distributors	3	C,K
M	Ship stock to distributors	5	I,L

- i. Draw the network diagram showing the inter-relations between the various activities of the project. [9mks]
- ii. Indicate the critical path. [2mks]
- iii. For each non-critical activity find the total and free float. [5mks]

**QUESTION 5: (20marks)**

- a) A company has five salesmen, who have to be allocated to three marketing zones. The return (or profit) from each zone depends upon the number of salesmen, working in that zone. The expected return for different number of salesmen in different zone, as estimated from the past records are given below

Number of salesmen	Marketing zone		
	1	2	3
0	45	30	35
1	58	45	45
2	70	60	52
3	82	70	64
4	93	79	72
5	101	90	82

Determine the optimal allocation policy

[8mks]

- b) Consider the problems of designing electronic device to carry five power cells, each of which must be located within three electronic systems. If one system's power fails, then it will be powered on an auxiliary basis by the cells of the remaining systems. The probability that any particular system will experience a power failure depends on the number of cells originally assigned to it

Estimated power failure probabilities for a particular system are given below

Power Cells	Probability of system power failure		
	System 1	System 2	System 3
1	0.60	0.70	0.50
2	0.25	0.30	0.35
3	0.14	0.20	0.20
4	0.12	0.15	0.15
5	0.11	0.12	0.15

Determine how many power cells should be assigned to each system to maximize the overall system reliability [12mks]