Name :
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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

07 THRISSUR CLUSTER

SECOND SEMESTER M.TECH. DEGREE EXAMINATION Oct 2021

Department Civil Engineering

Specialisation Environmental Engineering

07CE6116 ENVIRONMENTAL SYSTEMS ANALYSIS

Time : 3 hours **Max.Marks: 60**

Answer all six questions. Part 'a' of each question is compulsory.

Answer either part 'b' or part 'c' of each question

(Graph sheets may be provided.)

Q.no.	Module 1	Marks
1a	Explain the relevance of optimization models in Environmental systems management.	4

Answer b or c

b PM10 is generated from 2 cement factories, A and B using 3 different grades of lime stones L1, L2, and L3 while producing cement. The minimum to be produced at plants A and B is 85 and 75 tonnes respectively. The quantities of various grades of limestone required to generate 1 tonne of cement at each plant, pollution caused by various grades of limestone at plant, and the cost of limestone are given. Formulate the problem of determining the amount of different grades of limestone to be used at each plant to minimize a)the total pollution level and b) the total cost of operation. **5**

Limestone grade	Qty of limestone to generate 1 tonne of cement(tonnes)		Pollution caused (µg/tonne)		Cost of limestone (Rs/tonne)	
	A	B	A	B	A	B
L1	2.2	1.5	3.4	5.5	30	20
L2	2.5	3.2	2.5	2.9	25	25
L3	3.9	2.5	1.8	3.8	28	22

c Composting for organic manure is to be done for a mixture of 5 types of solid wastes. The Potassium value Ki, Phosphorus value Pi, and monetary value Mi of different solid wastes is given below. Formulate the problem for finding the amount of solid wastes selected from each type so that total monetary value of organic manure is maximum. The total Potassium and phosphorus of manure cannot exceed 600 and 450kg. **5**

Solid wastes	Ki(Kg/Kg)	Pi(Kg/Kg)	Mi(Rs/Kg)
1	3.5	3.8	10
2	5.4	7.9	8
3	3.3	6.5	7
4	4.5	6.9	8
5	4.8	6.6	9

Q.no. **Module 2** **Marks**

2a Illustrate the use of equations that are assimilation relationship which are used to find environmental quality in a water body at a point in space or time as a function of waste discharge at another point in space or time. **4**

Answer b or c

b It has been determined that runoff from 120 ha of cropland is carrying nitrates into a small lake and contributing to lake's eutrophication.2 crops are grown on 120 ha. Let pi=kg/ha/yr of nitrates that enters the lake in runoff from crop i. An environmental agency has determined that total input of nitrates to the lake from cropland runoff must not exceed 850 kg/yr. The farmer using 120 ha require minimum quantities of each crop (Li) and obtain net returns Ri (Xi) from crop I ($/yr) where Xi=ha of crop i. Construct an optimization model and solve **5**

Crop i	Pi(kg/ha)	Li(ha)	Ri(Xi))($/yr)
1	17	40	$1100\ X_1^{1/2}$
2	25	30	$3300\ X_2^{1/3}$

c Two types of fertilizers F1 and F2 are mixed to produce a new type Y. The ingredients of F1 and F2 and the requirements of Y are given in table. If F1 costs Rs 3.5/kg and F2 Rs 4.0/kg determine the amounts of F1 and F2 to be mixed to produce Y at minimum costs. **5**

Fertilizer	Composition by weight %	
	Organophosphate	Organonitrate
F1	75	10
F2	50	30
Y	>=60	>=20

Q.no.	Module 3	Marks
3a	Write the dual of the following LP problem. What does it address? Maximize Z= 350 Y1+180 Y2 St 1.8 Y1+2.6 Y2<=4400 Y1+Y2<=2000 Y1.,Y2>=0	4
	Answer b or c	
b	Explain segment variable method in separable programming. What are its limitations?	5
c	Linearize the following problem by segment weight method Max $Z1=3X^{1/4}+2Y-Z$ St $4X+10Y<=6$ $3X+4Y+0.5Z<=6$ $X,Y,Z>=0$	5

Q.no.	Module 4	Marks
4a	Explain the characteristics and applications of Dynamic programming.	4
	Answer b or c	
b	A municipality wishes to zone 80 hectares of land for 3 development types.(zoning in units of 20 hectares).Net tax revenues for the 3 developments in Rs 10^2/year are	5

Development1	Development2	Development3
$2A^{0.8}$	$A^{1.2}$	$1.1A^{0.9}$

A is in hectares. How should the municipality zone the area?

c A company produces 600,400 and 500 tonnes of compost from garbage during May, June and July. The maximum sales in each month is 300,700 and 600 tonnes respectively. Since there is mismatch between production and sales, a storage bin of capacity 400 tonne is constructed. The net income and storage cost is given below. Construct an optimization model and solve — 5

Sales in tonne	Net income in Rs !000		
	May	June	July
0	0	0	0
100	2	3	2
200	4	4	3
300	5	6	6
400		6	6
500		6	7
600		7	7
700		7	

Amt of storage at beginning of month in tonne	Monthly cost of storage in Rs !000		
	May	June	July
0	2	2	1
100	3	3	2
200	4	3	4
300	5	4	5
400	6	6	6

Q.no. **Module 5** **Marks**

5a Two towns are developing a joint plan for the disposal of solid wastes. Town A produces 250t/day and Town B 180t/day. Three disposal sites are available, but each has different capacities and costs as shown in table. Transportation cost is Rs 0.8/t/km. Construct a model for a joint disposal plan.(Formulation only) **5**

Disposal site	Disposal cost(Rs/t)	Capacity (t//day)	Distance (km) from	
			Town A	Town B
1	15	160	10	9
2	18	80	8	15
3	8	100	30	20

Answer b or c

b. A bank is in the process of devising a loan policy that involves a maximum of 12 million rupees. The following table provides pertinent data about the following types of loans. **7**

Type of loan	Interest rate	Bad-debt ratio
Personal	0.18	0.35
Car	0.24	0.17
Home	0.22	0.09
Farm	0.14	0.05
Commercial	0.10	0.08

Bad debts are unrecoverable and produce no interest revenue. Bank has to allocate at least 30% of funds to farm and commercial loans. Home loans should be at least equal to 45% of personal, car and home loans. The overall ratio of bad debts on all loans should not exceed 5%. Construct an optimization model for the above. (formulation only).

c In preparation for the agriculture season, a fertilizer company is manufacturing 4 types of fertilizers. F1,F2,F3,F4. All products are manufactured in different departments: cleaning, grinding, blending, and packaging. The company has received firm orders for its products. The contract stipulates a penalty for undelivered items. The following table provides the pertinent data of the situation. **7**

Department	Time per unit kg (Hr)				
	F1	F2	F3	F4	Capacity (Hr)
Cleaning	0.50	0.20	0.30	0.35	1400
Grinding	0.28	0.30	0.35	0.15	1200
Blending	0.45	0.50	0.40	0.22	1200
Packaging	0.25	0.20	0.10	0.05	950
Demand(Kg)	800	750	600	500	
Unit Profit (Rs)	30	40	20	10	
Unit penalty(Rs)	20	15	10	12	

Devise an optimal production plan for the company.(formulation only)

Q.no.	Module 6	Marks
6a	Briefly explain the various components of Expert systems	5

Answer b or c

b	Explain types of learning in ANN	7
c	Explain the evaluation of fitness function in optimization using Genetic algorithms.	7