

Name :
Reg No :



APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
07 THRISSUR CLUSTER

SECOND SEMESTER M.TECH. DEGREE EXAMINATION APRIL 2018

Department Civil Engineering
Specialisation Environmental Engineering
07CE6116 Environmental System 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
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1a	What is the significance of systems approach in Environmental management?	4
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Answer b or c

b	Composting for organic manure is to be done for a mixture of 5 types of solid wastes. The Nitrogen value N_i , Potassium value P_i , and monetary value M_i 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 Nitrogen and Potassium of manure cannot exceed 700 and 550kg.	5
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Solid wastes	Ni(Kg/Kg)	Pi(Kg/Kg)	Mi(Rs/Kg)
1	0.9	0.7	5
2	0.6	0.3	6
3	0.4	0.2	3
4	0.6	0.3	2
5	0.3	0.1	8

c	An electric utility company operates 2 thermal power plants, A and B, using 3 different grades of coal C1,C2,C3.The minimum power to be generated at plants A and B is 50 and 90 MWh respectively. The quantities of various grades of coal required to generate 1 MWh of power at each power plant, pollution caused by various grades of coal at each power plant, and the cost of coal are given. Formulate the problem of determining the amount of different grades of coal to be used at each power plant to minimize a) the total pollution level and b) the total cost of operation.	5
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Coal type	Qty of coal to generate (tons)		Pollution caused ($\mu\text{g/tons}$)		Cost of coal (Rs/ton)	
	A	B	A	B	A	B
C1	3.8	2.8	2.9	1.5	15	12
C2	2.0	3.0	1.5	2.8	18	36
C3	3.9	1.5	1.7	3.5	10	12

Q.no.

Module 2

Marks

- 2a** Explain nonpoint pollution and its management.

4

Answer b or c

- b** SPM 10 emission from a power plant is 55 kg/ton of coal burnt. Power plant burns 54000 tons/year of coal. The SPM10 emission has to be reduced by 65% by employing control measures. Feasible controls and associated cost are given. Cost (Rs/t) is in terms of SPM 10 treated. Find the optimum treatment option.

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Emission control	Efficiency	Cost (Rs/ton)
Venturi scrubber	96	25
Spray tower	82	18

- c** Two liquids A and B are mixed to produce a new mixture C. The compositions of A and B and the requirements of C are given in table. If B costs Rs 1.5/L and A Rs 1.8/L, determine the amounts of A and B to be mixed to produce C at minimum costs.

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Liquids	Composition by volume	
	Organic	Inorganic
A	75	8
B	55	15
C	≥ 65	≥ 25

Q.no.

Module 3

Marks

- 3a** Linearize the following problem by segment variable method
 Max $Z = 5X^{1/4} + 2Y - 3Z$
 St $6X + 10Y \leq 8$
 $X + 4Y + 0.8Z \leq 5$
 $X, Y, Z \geq 0$.

4

Answer b or c

- b** A manufacturing firm produces 2 goods A and B using raw materials, Cast iron and wrought iron. The amt required for each good and the total amount available and the profit on each good are given in the following table

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Type of raw materials	Amt required (kg)		Max available per week (Kg)
	A	B	
Cast iron	12	15	2000
Wrought iron	14	20	2500
Profit per unit	Rs 45	Rs 55	

Determine the number of goods A and B produced per week to maximize the profit. Use simplex method.

c

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Find the solution graphically

Minimize $f = -3X_1 + 2X_2$

st $0 \leq X_1 \leq 4$, $1 \leq X_2 \leq 6$ and $X_1 + X_2 \leq 5$

Q.no.

Module 4

Marks

- 4a** Explain the characteristics of Dynamic programming. Explain the applications of Dynamic programming

4

Answer b or c

- b** A city has been ordered to reduce the quantity of Ammonia Nitrogen in its sewage to 800 kg/day before discharge to river. The city has 3 sewage plants discharging 1200kg/day, 450 kg/day and 1000 kg/day of Ammonia Nitrogen. If X_i is the % Ammonia Nitrogen removed by additional treatment at plant i , the cost of each treatment in Rs/year is $28 X_1^2$, $18 X_2^2$ and $22 X_3^2$ at plants 1, 2 and 3. Construct an optimization model and solve.
- c** It has been determined that runoff from 180 ha of cropland is carrying quinaphos into a small lake and contributing topollution. 3 crops are grown on 180 ha. Let q_i =kg/ha/yr of quinaphos that enters the lake in runoff from crop i . An environmental agency has determined that total input of quinaphos to the lake from cropland runoff must not exceed 950 kg/yr. The farmer using 180 ha require minimum quantities of each crop (L_i) and obtain net returns R_i (X_i) from crop i (\$/yr) where X_i =ha of crop i . Construct an optimization model and solve

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Crop i	q_i (kg/ha)	L_i (ha)	$R_i(X_i)$ (\$/yr)
1	10	30	$1000 X_1^{1/2}$
2	12	60	$3000 X_2^{1/3}$
3	10	40	$1200 X_3^{1/2}$

Q.no.

Module 5

Marks

- 5a** . A university has developed a new pesticide that is effective in controlling corn, soya bean and wheat pests. The following improvements in crop yield have been obtained.

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Pesticide Application	Crop yields kg/ha		
	Soya bean	Wheat	Corn
0	2600	3500	5200
0.5	3300	3900	5400
1	3800	4100	5700
1.5	4100	3500	6300
2	4000	3200	7900

The annual costs of production not including pesticide application are Rs 260,200 and 300/ha for soya bean, wheat and corn. Pesticide application costs are 30/ha/yr for any crop at any application rate greater than 0. Environmental

authorities have expressed concern over pesticide's impact and ruled that farmer's coverage application rates on corn, Soya bean and wheat cannot exceed 1kg/ha (total pesticide application in kg to all the three divided by the crop area). Selling prices for Soya bean, wheat, and corn are 0.28, 0.18 and 0.12/kg respectively. A farmer has decided to grow 30 ha of soya bean 30 ha of wheat and 30 ha of corn. Construct a model to determine how much pesticide the farmer should use on each crop. Assume that farmer will not vary rates on any single crop.

Answer b or c

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

Type of loan	Interest rate	Bad-debt ratio
Personal	0.140	0.10
Car	0.130	0.07
Home	0.120	0.03
Farm	0.125	0.05
Commercial	0.100	0.02

Bad debts are unrecoverable and produce no interest revenue .Bank has to allocate at least 40% of funds to farm and commercial loans. Home loans should be at least equal to 50% of personal, car and home loans. The overall ratio of bad debts on all loans should not exceed 4%. 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, and blending,. 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. Devise an optimal production plan for the company(formulation only) **7**

Department	Time per unit kg (Hr)				
	F1	F2	F3	F4	Capacity (Hr)
Cleaning	0.40	0.30	0.25	0.15	1000
Grinding	0.25	0.25	0.30	0.10	1200
Blending	0.45	0.50	0.40	0.22	1100
Demand(Kg)	850	750	600	500	
Unit Profit (Rs)	30	45	25	10	
Unit penalty(Rs)	18	20	12	10	

Q.no.	Module 6	Marks
6a	Explain the use of genetic algorithm in optimization	5

Answer b or c

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| b | Explain the various components in Expert systems | 7 |
| c | Briefly explain the Architecture of ANN | 7 |