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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**

1a Illustrate with example the advantage of treating Environmental problems as systems. **4**

Answer b or c

b An electric utility company operates 2 thermal power plants, A and B. using 3 different grades of gasoline , G1.G2,G3.The minimum power to be generated at plants A and B is 65 and 75 MWh respectively. The quantities of various grades of gasoline required to generate 1 MWh of power at each power plant, pollution caused by various grades of gasoline at each power plant, and the cost of gasoline are given. Formulate the problem of determining the amount of different grades of Gasoline to be used at each power plant to minimize a)the total pollution level and b) the total cost of operation. **5**

Gasoline type	Qty of gasoline to generate 1 MWh (tons)		Pollution caused (µg/tons)		Cost of Gasoline (Rs/ton)	
	A	B	A	B	A	B
G1	2.2	1.8	2.2	3.6	23	15
G2	2.0	3.2	1.5	2.6	18	26
G3	1.5	2.6	1.7	3.5	16	12

c A farm uses at least 890 lb of organic manure daily. The manure is a mixture of vegetable waste and meat wastes with the following compositions. **5**

	lb per lb of waste		
Organic waste	Nitrogen Content	Carbon Content	Costs ($/lb)
Vegetable	0.09	0.65	0.30
Meat	0.14	0.62	0.90

The nutrient requirements of the manure are at least 12 % nitrogen and at most 75% of carbon. The farm wishes to determine the daily minimum cost organic mix. Formulate the above.

Q.no.	Module 2	Marks
2a	Explain with a neat graph NBOD and C BOD.	**4**

Answer b or c

b SPM 2.5 emission from a power plant is 65 kg/ton of coal burnt. Power plant burns 50000 tons/year of coal. The SPM2.5 emission has to be reduced by 75% by employing control measures. Feasible controls and associated cost are given. Cost (Rs/t) is in terms of SPM 2.5 treated. Find the optimum treatment option. **5**

Emission control	Efficiency	Cost (Rs/ton)
Fabric filter	80	3.0
ESP	95	9..5

c It is proposed to build railway stations at three different sites. The total budget available is 3 units. (1unit=$4 million) and the feasible level of investment on any station are 0,1,2,or 3 units. The revenue obtainable (return functions) for different investments are given below. Find the investment policy for maximizing the total revenue.. **5**

Return function	Thermal station,i		
Ri(x)	1	2	3
Ri(0)	0	0	0
Ri(1)	3	1	4
Ri(2)	4	5	5
Ri(3)	6	8	6

Q.no.	Module 3	Marks
3a	Linearize the following problem by segment variable method Max Z1=3X $^{1/4}$+2Y-Z St 4X+10Y<=6 3X+4Y+0.5Z<=6 X,Y,Z>=0.	**4**

Answer b or c

b A factory has set a goal of reducing wastes. The factory produces HCl and H_2SO_4 whose net profits are Rs 130/litre and Rs 200/litre. Minimum sales commitment for HCl and H_2SO_4 are 790litre /day and 800litre /day. The factory has decided to limit the waste production to no more than 40000litres/day of liquid waste and 250 Kg/day of particulates. Determine the optimal product mix for the factory. The waste produced per litre of HCl and H_2SO_4 are given. Use simplex method **5**

Product	Liquid wastes(litre/day)	Particulates (kg/day)
HCl	2.5	0.06
H_2SO_4	1.5	0.08

c A firm produces 2 grades of sulphur fuels S1 and S2 using 2 grades of coal C1, and C2. The amount required for each Kg of fuel and the total amount available and the profit on each fuel are given in the following table **5**

Grade of Coal	Amt required (kg)		Max available per week(Kg)
	S1	S2	
C1	20	15	2200
C2	15	18	1000
Profit per Kg	Rs 65	Rs 60	

Determine the amount of fuel S1 and S2 produced per week to maximize the profit. Use simplex method.

Q.no. **Module 4** **Marks**

4a What types of problems can be solved by Dynamic programming? Explain limitations and advantages of Dynamic programming **4**

Answer b or c

b A city has been ordered to reduce the quantity of TDS in its sewage to 700 kg/day before discharge to river. The city has 3 sewage plants discharging 1000kg/day,650 kg/day and 1300 kg/day of TDS. If Xi is the % TDS removed by additional treatment at plant i, the cost of each treatment in Rs/year is 25 $X1^2$,15 $X2^2$ and 20$X3^2$ at plants 1, 2 and 3. Construct an optimization model and solve. **5**

c It has been determined that runoff from 150 ha of cropland is carrying phosphorus into a small lake and contributing to lake's eutrophication.3 crops are grown on 150 ha. Let pi=kg/ha/yr of phosphorus that enters the lake in runoff from crop i. An environmental agency has determined that total input of Phosphorus to the lake from cropland runoff must not exceed 850 kg/yr. The farmer using 150 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	10	30	$1000\ X_1^{1/2}$
2	12	20	$3000\ X_2^{1/3}$
3	10	20	$1200\ X_3^{1/2}$

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

5a Combined TSP emission from 3 sources is to be reduced to 14600000kg/year.TSP emission factor and feasible controls are shown. . Write the objective function and constraints for managing the problem in the most effective way. **5**

TSP emission

	sources		
	Power plant 1	Power plant 2	Cement factory
Coal used/ cement manufactured (T/year)	600000	400000	350000
TSP emission Kg/T	96	90	85

Control alternatives and costs in Rs/T of coal or cement

Control method	Costs Rs/T			Efficiency
	Power plant 1	Power plant 2	Cement factory	
Settling chamber	1.0	1.4	1.1	59
Multiple Cyclone	-	-	1.2	74
Long cone cyclone	-	-	1.5	84
Spray scrubber	2.0	2.2	3.0	94

Answer b or c

b Two cities are developing a joint plan for the disposal of MSW. City 1 produces 150t/day and city 2, 160t/day. Three disposal sites are available, but each has different capacities and costs as shown in table. Transportation cost is Rs 0.7/t/km. Construct a model for a joint disposal plan **7**

Disposal site	Disposal cost(Rs/t)	Capacity (t//day)	Distance (km) from	
			City 1	City 2
1	16	165	19	10
2	18	90	12	15
3	9	220	32	25

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	0.30	0.30	0.25	0.15	1000
Grinding	0.25	0.35	0.30	0.10	1000

Blending	0.45	0.50	0.40	0.22	1000
Demand(Kg)	800	750	600	500	
Unit Profit (Rs)	30	40	20	10	
Unit penalty(Rs)	15	20	10	8	

Q.no.	Module 6	Marks
6a	Explain population selection and fitness function in Genetic Algorithms	**5**
	Answer b or c	
b	Explain the drawbacks of expert systems in environmental management	**7**
c	Explain types of learning in ANN	**7**