SOMAIYA VIDYAVIHAR UNIVERSITY

Trim: Sep-Dec 24 **Maximum Marks: 50 Examination: ETE Exam Date: 14/01/2025 Duration: 3 Hours**		
Programme code: -1 **Programme: MBA**	**Class:** SY	**Semester/Trimester: V**
College: K. J. Somaiya Institute of Management	**Name of the department/Section/Center: Business Analytics**	
Course Code: 217P01C513	**Name of the Course: Optimization Models for Business Decisions**	

Instructions:

1. **There are 3 sections. Each Section carries 25 marks.**
2. **Attempt any 2 out of the 3 sections. All questions within a section are compulsory.**
3. **Make suitable assumptions if required and state them.**
4. **Write all relevant answers and interpretations in your Excel sheet, with sufficient details in an easily readable manner to enable a fast evaluation of your answers.**
5. **Keep saving the file every ten minutes or so.**
6. **Make only 1 Excel file with different worksheets pertaining to each question.**
7. **The naming convention for the file should have your roll number and name.**
8. **Please follow the instructions of the faculty/IT staff on duty.**

Question No.	Section A	Max. Marks
Q1	Burnside Marketing Research conducted a study for Barker Foods on some designs for a new dry cereal. Three attributes were found to be most influential in determining which cereal had the best taste: ratio of wheat to corn in the cereal flake, type of sweetener (sugar, honey, or artificial), and the presence or absence of flavor bits. Seven children participated in taste tests and provided the following part-worths for the attributes:	11

	Wheat/Corn		Sweetener			Flavor Bits	
Child	Low	High	Sugar	Honey	Artificial	Present	Absent
1	15	35	30	40	25	15	9
2	30	20	40	35	35	8	11
3	40	25	20	40	10	7	14
4	35	30	25	20	30	15	18
5	25	40	40	20	35	18	14
6	20	25	20	35	30	9	16
7	30	15	25	40	40	20	11

Assume the overall utility of the current favorite cereal for the first four children in the group is 70, and the overall utility of the current favorite cereal for the last three children in the group is 80. What is the product design that will maximize the share of choices for the seven children in the sample?

Q2	The Soft-Ad Company is planning for the next month an advertising campaign for one of its clients, Amco. Soft-Ad is considering advertising during sports programmes and during soap operas on TV. Amco has specified the following goals: Goal 1 Reach at least 20 lakh high-income-males (HIM) Goal 2 Reach at least 30 lakh medium-income-families (MIF) Goal 3 Reach at least 15 lakh high-income-females (HIF). The information about cost and viewers for each one-minute ad slots is given below:	14

Ad-slot	Number of viewers per Ad (in lakhs)			Cost per slot (Rs)
	HIM	MIF	HIF	
Sports	4	5	2	2,00,000
Soap opera	3	8	4	3,00,000

Further, the company has budgeted Rs 12 lakhs for these advertisements, which should not be exceeded. It has also estimated that each lakh of viewers by which it falls shorts of goal 1 costs it Rs 2 lakhs on account of lost sales. Similarly, this penalty for goals 2 and 3 is Rs 1 and 0.8 lakh respectively. How should Soft-Ad plan for Amco? Formulate and solve this as a goal linear programming problem.

Section B

Q3

Garden City Beach is a popular summer vacation destination for thousands of people. Each summer, the city hires temporary lifeguards to ensure the safety of the vacationing public. Garden City's lifeguards are assigned to work five consecutive days each week and then have two days off. However, the city's insurance company requires them to have at least the following number of lifeguards on duty each day of the week:

Minimum Number of Lifeguards Required Each Day

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Lifeguards	18	17	16	16	16	14	19

The city manager would like to determine the minimum number of lifeguards that will have to be hired.

a. Formulate an ILP for this problem.

b. Implement your model in a spreadsheet and solve it.

What is the optimal solution?

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Q4

Home-Base, a home improvement and building supply chain, is going to build a new warehouse facility to serve its stores in six North Carolina cities—Charlotte, Winston-Salem, Greensboro, Durham, Raleigh, and Wilmington. The coordinates of these cities (in miles), using Columbia, South Carolina, as the graphical origin (0, 0), and the annual number of truckload trips that need to be done to each store are to complete the supply as follows:

Store	Coordinates		Truckload
	x	*y*	
Charlotte	15	85	160
Winston-Salem	42	145	90
Greensboro	88	145	105
Durham	125	140	35
Raleigh	135	125	60
Wilmington	180	18	75

Home-Base wants to determine the set of coordinates for the new warehouse that will minimize the total miles traveled to the stores and identify on a map the closest town to these stores such that no store is farther than 150 miles away from this town.

Formulate and solve the above problem.

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Section C

Q5

In his position as vice president of research and development (R&D) for CRT Technologies, Mark Schwartz is responsible for evaluating and choosing which R&D projects to support. The company received 18 R&D proposals from its scientists and engineers, and identified 6 projects as being consistent with the company's mission. However, the company does not have the funds available to undertake all six projects. Mark must determine which of the projects to select. The funding requirements for each project are summarized in the following table along with the NPV the company expects each project to generate.

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			Capital (in $1,000s) Required in				
	Project	Expected NPV (in $1,000s)	Year 1	Year 2	Year 3	Year 4	Year 5
	1	$141	$ 75	$25	$20	$15	$10
	2	$187	$ 90	$35	$ 0	$ 0	$30
	3	$121	$ 60	$15	$15	$15	$15
	4	$ 83	$ 30	$20	$10	$ 5	$ 5
	5	$265	$100	$25	$20	$20	$20
	6	$127	$ 50	$20	$10	$30	$40

The company currently has $250,000 available to invest in new projects. It has budgeted $75,000 for continued support for these projects in year 2 and $50,000 per year for years 3, 4, and 5. Surplus funds in any year are reappropriated for other uses within the company and may not be carried over to future years. Further, the company has some limitations:

a. The company wants to limit the solution to include no more than one of the three projects 1, 3 or 6.

b. Project 4 involves a cellular communications technology that will not be available to the company unless it undertakes project 5.

Solve the above model to maximize the total NPV while satisfying the requirements of the company.

Q6

Investment manager Max Gaines has several clients who wish to own a mutual fund portfolio that matches, as a whole, the performance of the S&P 500 stock index. His task is to determine what proportion of the portfolio should be invested in each of the five mutual funds listed below so that the portfolio most closely mimics the performance of the S&P 500 index. Solve the above problem to obtain the optimal proportion of portfolio to be invested in each of the five mutual funds.

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	Annual Returns (Planning Scenarios)			
Mutual Fund	Year 1	Year 2	Year 3	Year 4
International Stock	26.73	22.37	6.46	−3.19
Large-Cap Blend	18.61	14.88	10.52	5.25
Mid-Cap Blend	18.04	19.45	15.91	−1.94
Small-Cap Blend	11.33	13.79	−2.07	6.85
Intermediate Bond	8.05	7.29	9.18	3.92
S&P 500 Index	21.00	19.00	12.00	4.00

Q7

Table below shows data on the returns over five 1-year periods for seven mutual funds. A firm's portfolio manager will assume that one of these scenarios will accurately reflect the investing climate over the next 12 months. The probabilities of each of the scenarios occurring are 0.2, 0.2, 0.1, 0.3, and 0.2 for years 1 to 5, respectively.

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RETURNS OVER FIVE 1-YEAR PERIODS FOR SIX MUTUAL FUNDS

	Planning Scenarios for Next 12 Months				
Mutual Funds	Year 1	Year 2	Year 3	Year 4	Year 5
Large-Cap Stock	35.3	20.0	28.3	10.4	−9.3
Mid-Cap Stock	32.3	23.2	−0.9	49.3	−22.8
Small-Cap Stock	20.8	22.5	6.0	33.3	6.1
Energy/Resources Sector	25.3	33.9	−20.5	20.9	−2.5
Health Sector	49.1	5.5	29.7	77.7	−24.9
Technology Sector	46.2	21.7	45.7	93.1	−20.1
Real Estate Sector	20.5	44.0	−21.1	2.6	5.1

A model needs to be developed for a risk-taking investor who is willing to take the risk of minimum 1% return under any given scenario. Solve the above problem using an optimization model for this investor whose objective is to identify the optimal proportion to invest in each mutual fund so as to maximize the expected return from the portfolio.