

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
Model Question

Exam	Regular		
Level	B.E.	Full Marks	60
Program	BIE	Pass Marks	24
Year/Part	III/II	Time	3 hrs

Subject: Operations Research

ENIE 352

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt **ALL** questions.
- ✓ Assume suitable data if necessary.

Examination must be conducted in a computer lab. Each student has to be provided with a PC, which must have Microsoft Office and CRYSTAL BALL Pro. The Microsoft Office must have EXCEL with SOLVER and Analysis Tool Pack. Each student must be provided with a Pen-drive to attempt the questions and save them or his answer to be copied in a pen drive. If the PC has some problem, the student should be provided with another usable PC and the time elapsed should be considered.

1	Velocity Logistics LLC manufactures a high-demand electronic component at three different production plants and distributes them to four regional distribution centers (DCs). Because of differing labor laws, local utility rates, and regional shipping contracts, both the production capacities, regional demands, and per-unit shipping costs vary across the network. Given Data 1. Plant Capacities (Supply): 1. Plant A: 400 units/week 2. Plant B: 600 units/week 3. Plant C: 500 units/week 4. <i>Total Supply = 1,500 units</i> 2. Distribution Center Requirements(Demand) 1. DC 1: 300 units/week 2. DC 2: 350 units/week 3. DC 3: 450 units/week 4. DC 4: 400 units/week 5. <i>Total Demand = 1,500 units</i> <table><tr><td>From/To</td><td>DC 1</td><td>DC 2</td><td>DC 3</td><td>DC4</td></tr><tr><td>Plant A</td><td>\$4</td><td>\$7</td><td>\$3</td><td>\$6</td></tr><tr><td>Plant B</td><td>\$8</td><td>\$5</td><td>\$6</td><td>\$4</td></tr><tr><td>Plant C</td><td>\$5</td><td>\$6</td><td>\$8</td><td>\$3</td></tr></table> Set up this linear programming model and find the optimal shipping schedule. Also find: i. If the shipping route between Plant A and DC 3 is completely blocked due to road maintenance, how does the optimal shipping plan and total cost change? ii. If management can expand capacity by 100 units at either Plant A or Plant B at the same capital cost, which plant should be expanded to maximize overall logistics savings?	From/To	DC 1	DC 2	DC 3	DC4	Plant A	\$4	\$7	\$3	\$6	Plant B	\$8	\$5	\$6	\$4	Plant C	\$5	\$6	\$8	\$3	[12]
From/To	DC 1	DC 2	DC 3	DC4																		
Plant A	\$4	\$7	\$3	\$6																		
Plant B	\$8	\$5	\$6	\$4																		
Plant C	\$5	\$6	\$8	\$3																		
2	Davis McKeown is the owner of a resort hotel and convention center in Myrtle Beach, South Carolina. Although his business is profitable, it is also highly seasonal; the summer months are the most profitable time of year. To increase profits during the rest of the year, Davis wants to expand his convention business but, to do so, he needs to expand his conference facilities. Davis hired a marketing research firm to determine the number and sizes of conference rooms	[12]																				

	that would be required by the conventions he wants to attract. The results of this study indicated that Davis’s facilities should include at least 5 small (400 square foot) conference rooms, 10 medium (750 square foot) conference rooms, and 15 large (1,050 square foot) conference rooms. Additionally, the marketing research firm indicated that if the expansion consisted of a total of 25,000 square feet, Davis would have the largest convention center among his competitors which would be desirable for advertising purposes. While discussing his expansion plans with an architect, Davis learned that he can expect to pay \$18,000 for each small conference room in the expansion, \$33,000 for each medium conference room, and \$45,150 for each large conference room. Davis wants to limit his expenditures on the convention center expansion to approximately \$1,000,000. i. Formulate this as a standard linear programming problem to find the exact rooms to construct satisfying above conditions. ii. Calculate the total cost and total area if Davis builds <i>exactly</i> the minimum required rooms (5 small, 10 medium, 15 large). Is this minimum configuration within the \$1,000,000 budget, and does it satisfy the 25,000 sq ft goal?																																																									
3.	Himalayan Beverages & Consumer Goods Pvt. Ltd., a leading FMCG distribution enterprise based in the Birgunj-Kathmandu trade corridor, manages wholesale distribution across key regional hubs including Kathmandu Valley, Pokhara, Butwal, and Biratnagar. The operations team has observed substantial seasonal fluctuations driven by Nepal's distinct socio-cultural and climatic patterns: Concurrently, expanding road networks, retail digitization, and urban migration across the Terai and hilly regions have created a sustained year-over-year upward trend in baseline demand. Using the Holt-Winters Additive Method, calculate the quarterly demand forecasts for all four quarters of Year 5 and Year 6. <table><thead><tr><th>Year</th><th>Qtr</th><th>Period (t)</th><th>Actual Demand (Yt)</th></tr></thead><tbody><tr><td rowspan="4">1</td><td></td><td>1</td><td>150</td></tr><tr><td></td><td>2</td><td>110</td></tr><tr><td></td><td>3</td><td>190</td></tr><tr><td></td><td>4</td><td>250</td></tr><tr><td rowspan="4">2</td><td></td><td>1</td><td>180</td></tr><tr><td></td><td>2</td><td>130</td></tr><tr><td></td><td>3</td><td>220</td></tr><tr><td></td><td>4</td><td>290</td></tr><tr><td rowspan="4">3</td><td></td><td>1</td><td>210</td></tr><tr><td></td><td>2</td><td>155</td></tr><tr><td></td><td>3</td><td>250</td></tr><tr><td></td><td>4</td><td>330</td></tr><tr><td rowspan="4">4</td><td></td><td>1</td><td>240</td></tr><tr><td></td><td>2</td><td>180</td></tr><tr><td></td><td>3</td><td>285</td></tr><tr><td></td><td>4</td><td>375</td></tr></tbody></table>	Year	Qtr	Period (t)	Actual Demand (Yt)	1		1	150		2	110		3	190		4	250	2		1	180		2	130		3	220		4	290	3		1	210		2	155		3	250		4	330	4		1	240		2	180		3	285		4	375	[12]
Year	Qtr	Period (t)	Actual Demand (Yt)																																																							
1		1	150																																																							
		2	110																																																							
		3	190																																																							
		4	250																																																							
2		1	180																																																							
		2	130																																																							
		3	220																																																							
		4	290																																																							
3		1	210																																																							
		2	155																																																							
		3	250																																																							
		4	330																																																							
4		1	240																																																							
		2	180																																																							
		3	285																																																							
		4	375																																																							
4.	Sakura Heavy Industries operates a multi-line industrial equipment plant and must commit to a primary production layout strategy for the upcoming fiscal cycle. The Director of Operations (Player A) is evaluating three configurations: A₁ (High-Volume Dedicated Line), optimized for mass output at low per-unit cost; A₂ (Flexible Cellular Manufacturing), structured for quick changeovers and batch variability; and A₃ (Lean Modular Pods), designed around low footprint and pull-based flow. The financial performance of each strategy depends on external market volatility and competitor dynamics (Player B). The market conditions are characterized by: B₁ (Severe Raw	[12]																																																								

Material Inflation), which compresses margins on rigid high-volume runs; B_2 (Surge in Customized Rush Orders), favoring rapid setup times; and B_3 (Broad Industrial Downturn), where holding unabsorbed capacity causes significant losses.
The payoff matrix below represents the plant's quarterly net operating profit buffer (in units of NPR 100,000) under each strategic combination:

Strategy	B_1 (Material Inflation)	B_2 (Custom Order)	B_3 (Market Downturn)
A_1 (Dedicated Line)	8	-4	6
A_2 (Cellular Manufacturing)	-2	6	4
A_3 (Lean Modular Pods)	5	3	-2

Determine:

- based on these criteria, determine whether a stable pure-strategy saddle point exists for this zero-sum game
- Formulate the payoff matrix into a Linear Programming Problem (LPP) for Player A to maximize expected returns.
- Calculate the optimal mixed strategy probabilities for both players and find the value of the game (V).

5. Apex Logistics Inc. operates a rapidly expanding regional freight delivery fleet. The finance department must determine the cash reserve to accrue over the next 12 months to cover unpredictable maintenance and repair claims across its self-insured delivery vans.

[12]

i. Fleet Funding Structure:

- Maintenance costs are funded through two streams: a driver monthly contribution/deduction of \$150 per active vehicle and the company reserve fund (which covers any shortfall between actual repair costs and driver contributions).
- At the end of the previous month, exactly 1,200 vehicles were active in the fleet.
- The baseline average repair cost per vehicle was \$320 per month last month.

ii. Operational Parameters:

- Monthly Fleet Size Fluctuations: Due to vehicle acquisitions, retirements, and lease renewals, the month-over-month percentage change in active vehicles follows a Uniform Distribution between a 2% decrease (-2%) and an 8% increase (+8%).
- Average Repair Cost Inflation & Variance: Due to parts inflation and severe weather, the mean repair cost per vehicle increases by 1.5% each month, with actual monthly costs following a Normal Distribution with a constant Standard Deviation (σ) of \$12.

Build a 12-month simulation model in Excel, define the assumptions and total annual company fund requirement forecast in Crystal Ball, run 10,000 trials, and determine:

	i. The expected (mean) total annual expenditure that Apex Logistics must allocate from company funds to cover net maintenance claims. ii. The maximum (worst-case) and minimum (best-case) net annual company cash requirement observed across the simulation. iii. The minimum cash reserve the company must set aside to be 95% certain that annual repair claims will be fully covered without causing a liquidity deficit. iv. The probability that the required company contribution for the entire year will exceed \$3,000,000. v. The probability that the annual company expenditure will fall within the budget window of \$2,400,000 to \$2,800,000.	
--	---	--