EM384, AT 23-2 NAME Solution SECTION ________

WPR 2

Lesson 27 (55 minutes) – In Lab

Version 1

Login Name: .\secadet
Password: G0Systems2015!@
First Window: type EM384
Second Window: Section_LastName_FirstName
Open Excel Document

DOCUMENTATION. This WPR is an individual assignment – CLOSED BOOK and CLOSED NOTES. You may not use your computers or any digital media which is on your computer. No collaboration, e-mail, or internet use is authorized. You may ask questions of your instructor while doing the WPR. You may not depart the lab with these materials.

WPR Instructions

- Use this WPR Handout to formulate the problem and answer any questions. Fill-in your answer on this handout in the space provided and complete the digital work in Excel.
- This WPR consists of four separate problems.
- You are authorized to use a pencil, straight edge, issued calculator, and Excel.

Turn in requirements:

- Turn in the hard copy of your answer sheet prior to your departure. Make sure your name is on each page of the answer sheet.
- Submit your digital Excel file by saving the Excel file to the desktop and dragging the Excel file to the turn-in folder (on your lab computer desktop). **Confirm your instructor has received your Excel file before logging off of the computer.**

- Do not turn the page or begin work in Excel until told to do so by your instructor.
- Do not share any portion of this exam with another student.
- Save your Excel file early and often. Do not save this file to anywhere other than the Desktop of your workstation.
- You may not discuss any aspects of this WPR with anyone except an EM384 instructor until the Course Director has issued the 'all clear'.

I acknowledge that I have read and will comply with all instructions given above.

Cadet Signature: ______________________________

Grading Summary

Problem / Part	Points Available	Points Received
Problem 1	75	
Problem 2	50	
Problem 3	25	
Total:	150	

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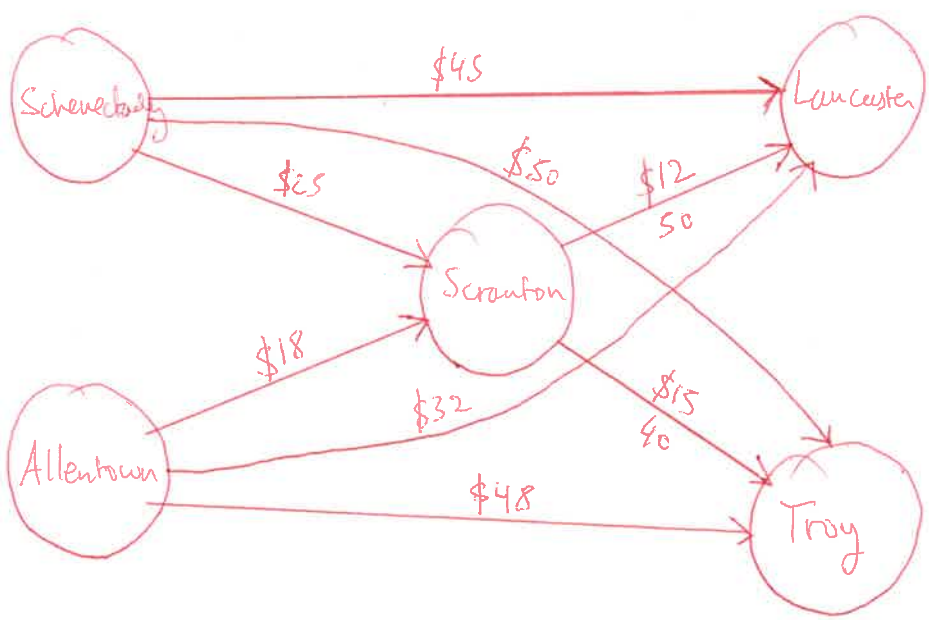
1. Transshipment Problem (75 points)

You are the distribution manager for the Black and Gold (B&G) T-shirt company. **Your goal is to minimize the total cost of shipping your T-shirts** while meeting the storefront demand. You have a cost table for shipping boxes of T-shirts from your warehouses (Schenectady, Allentown) to your retail storefronts located in large malls (Lancaster, Troy). A contractor has also provided the unit shipping cost (per box) for shipping from/to their transshipment location (Scranton). This contractor allows you to ship a maximum of 50 boxes from Scranton to Lancaster and a maximum of 40 boxes from Scranton to Troy. Finally, you use the supply and demand quantities given in the table.

From / To	Scranton	Lancaster	Troy	**Supply**
Schenectady	$25	$45	$50	180
Allentown	$18	$32	$48	220
Scranton		$12	$15	
Demand		200	250	

Table 1: Unit shipping cost per box of T-shirts. Box supply and demand quantities.

1.1 Draw a complete network Flow Diagram for this problem. Ensure your diagram is legible and neat. **(15pts)**



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1.2 Formulate this problem algebraically as a linear program, using DOC. Your decision variables and formulation should be consistent with your network flow diagram **(25pts)**

D: Let x_{ij} be the number of boxes transported from node i to node j, $\forall i \in \{1,2,3\}$ $j \in \{3,4,5\}$ and $i \neq j$, where

	i
Schenectady	1
Allentown	2
Scranton	3
Lancaster	4
Troy	5

O: Minimize Cost

$$Z = 25x_{13} + 45x_{14} + 50x_{15} + 18x_{23} + 32x_{24} + 48x_{25} + 12x_{34} + 15x_{35}$$

C:

Supply:

$x_{13} + x_{14} + x_{15} = 180$

$x_{23} + x_{24} + x_{25} = 220$

Flow Balance

$x_{13} + x_{23} = x_{34} + x_{35}$

Demand

$x_{14} + x_{24} + x_{34} \leq 200$

$x_{15} + x_{25} + x_{35} \leq 250$

Capacity

$x_{34} \leq 50$

$x_{35} \leq 40$

Non-Negativity

$x_{ij} \geq 0 \quad \forall i \in \{1,2,3\}$ and $j \in \{3,4,5\}$, $i \neq j$

1.3 Model and solve this problem in an Excel sheet named 1.3 (A shell with Table 1 values has been provided for your convenience). Report the optimal decision variable values and optimal objective function value below. **(35pts)**

Number of boxes shipped from Schenectady to Scranton: 20

Number of boxes shipped from Allentown to Scranton: 70

Optimal objective function value: \$15,760

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2. Mixed Problems (50 points)

The Black Rifle Ammo Company (BRAC), operates an ammunition factory in Northern New Jersey. For greater efficiency, the chief operating officer (COO) has always devoted the factory to producing one caliber of ammunition at a time: 9mm NATO. The chief financial officer (CFO) has now advised him to diversify the production line to hedge against unstable market conditions. In response, the COO decided to add the .45 ACP and 5.56mm NATO caliber rounds to their catalogue, and has come up with the following linear program to determine how many pallets of each should be produced to maximize total profit.

Decision Variables:

Let x_1 be the number of 9mm NATO pallets produced

Let x_2 be the number of .45 ACP pallets produced

Let x_3 be the number of 5.56mm NATO pallets produced

Objective Function:

Maximize total profit (in \$) $Z = 4000x_1 + 5000x_2 + 7000x_3$

Constraints:

$25x_1 + 30x_2 + 75x_3 \leq 3000$ (Powder cases available)

$48x_1 + 50x_2 + 150x_3 \leq 5000$ (Machine time available, in hours)

$x_3 \geq 15$ (Minimum order number for 5.56 NATO)

$x_1, x_2, x_3 \geq 0$ (Non-negativity)

2.1 Model and solve this linear program in an Excel sheet named 2.1. Report the optimal decision variable values and optimal objective function value below. (**30pts**)

Optimal number of 9mm NATO pallets produced: 0

Optimal number of .45 ACP pallets produced: 55

Optimal number of 5.56mm NATO pallets produced: 15

Optimal objective function value: \$380,000

2.2 Assume for this part that the COO created **a new model with updated constraint parameters, but with the same objective function equation**. Answer the following questions, in the context of this problem.

The COO tells you that his solution doesn't produce any .45 ACP pallets, but that its **reduced cost** is -100. Using this information, what new unit profit for .45 ACP pallets would make the company want to produce them? (**10pts**)

5000-(-100)=\$5100

The COO tells you that the **shadow price** for "machine time available" is 80 and that he can get 20 more machine time hours for the low cost of \$1500. He also states that 20 hours is within the allowable increase. Should he take this deal? (justify your answer with any calculations) (**10pts**)

New profit changes by (80)(20) = \$1600

The deal costs \$1500 so he should take this deal so he gets \$100 extra dollars.

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3. Binary Decision Variables (25 points)

There are five projects that we can perform. We define y_i as a binary decision variable for project i. Let $y_i = 1$ if project i is performed; Let $y_i = 0$ if project i is not performed; Write a single equation constraint to enforce the logic in each of the following situations:

3.1 Project 1 and project 2 both must be performed. (**5pts**)

$$y_1 + y_2 = 2$$

3.2 If you perform project 3, then you must also perform project 4. (**5pts**)

$$y_3 \leq y_4$$

3.3 You may perform project 4 or project 5, but you may not perform both (You may perform neither). (**5pts**)

$$y_4 + y_5 \leq 1$$

3.4 Out of 5 total projects, you may perform at most 3. (**5pts**)

$$y_1 + y_2 + y_3 + y_4 + y_5 \leq 3$$

3.5 No other projects can be performed unless project 1 is also performed. (**5pts**)

$$4y_1 \geq y_2 + y_3 + y_4 + y_5$$