EM384: Analytical Methods for Engineering Management
AT 23-2
Name:
Section :

Homework Set 5

This assignment is worth 20 points, and is due NLT 1700 the day of Lesson 18. Late submissions will be penalized 1 point (5% of the assignment) for each 24-hour period late after the due time - with assignments turned in more than 7 days late receiving 0 points.

- **Documentation**. This deliverable is an individual assignment. Any assistance received must be documented in detail. Document all sources in accordance with the Office of the Dean Pamphlet "Documentation of Academic Work," (June 2015), Appendix E, and course guidance. e-Acknowledge documentation must be turned in through CIS at the time of submission. The deliverable is considered late until all portions of the assignment and the documentation are submitted.
- **Turn-In Requirement**: You will turn in **two files** to microsoft Teams: **One PDF file** (this assignment with your responses filled in the blanks), and **one Excel file** (extension .xlxs) with your model for Problem 1, with the following naming convention:

  Section_LastName_FirstName_EM384_Homework_4

  Remember that engineering management is about communicating. You will be graded on the clarity and structure of your work.
- **Acknowledgement Statement**: This assignment must be accompanied by a signed e-Acknowledgement Statement (DAW) to be eligible for graded credit. If you submit your files(s) but fail to sign the e-Acknowledgement Statement, your assignment will be considered late until the e-Acknowledgement Statement is signed.
- **Guidelines for Documenting Assistance**: For this assignment, individual work is highly encouraged, but collaboration between individuals is allowed. ALL collaboration must be documented. Any discussion of this problem set with anyone other than an EM384 instructor requires documentation. Documentation must be specific and detail the topics discussed and actions taken.
- You must be very specific (which problem, what assistance, etc.) when explaining any assistance used in your documentation or you will be deducted at a higher penalty. Assistance *may* result in a deduction of points in accordance with a holistic assessment by your instructor.
- Sharing of electronic files via email or any other electronic means is strongly discouraged. Using, copying, or being dictated someone else's work will result in a greater point deduction.

1. **Model and Solve a Linear Program Using Excel Solver (4 Points)**

   As a signal company commander, you are responsible for scheduling personnel to staff the Network Enterprise Center (NEC) which provides C4IM (Command, Control, Communications, Computers, and Information Management) services for your installation. The NEC provides support from 0400-2300 daily. After monitoring the usage of the center for several months, you have determined that the following number of civilian personnel are needed to maintain the installations networks:

Time of Day	**Min Number of Personnel**
0400-0900	10
0900-1200	16
1200-1800	8
1800-0400	14

   Two types of personnel can be scheduled: full-time Department of the Army Civilians (DACs) or part-time contractors. The DACs work for eight consecutive hours in any of the following shifts: **morning** (0400-1200), **afternoon** (1200-2000), and **evening** (2000-0400). Part-time contractors can be hired to work any of the same shifts as DACs. However, contractors cannot be on duty by themselves at any point (if any contractors are on duty, there must also be at least one DAC on duty). The pay scale for DACs and contractors is given in the table below:

Shift	**Morning**	**Afternoon**	**Evening**
DAC Pay	\$40	\$40	\$40
Contractor Pay	\$35	\$35	\$45

   (a) **(5 Points)** Construct a linear programming model using DOC to minimize total staffing cost. (use additional space on next page as necessary):

Part (a) additional space:

(b) **(6 Points)** Construct a spreadsheet model in Excel (in a tab named 1.b) to solve your linear program, and determine the minimum-cost staffing plan for the NEC.

(c) **(4 Points)** Solve your linear program and report the optimal decision variable values below, in addition to the optimal objective function value.

- Number of Contractors on **morning** shift:
- Number of Contractors on **afternoon** shift:
- Number of DACs on **evening** shift:
- Minimum Total Staffing Cost:

2. **Interpret a Sensitivity Analysis generated from Excel Solver (5 Points)**

Using the sensitivity Report from Excel below, answer the questions below, or if there is not enough information, what you would do to find the answer.

Objective Cell (Min)

Cell	Name	Original Value	Final Value
C15	Min. Cost	$1.90	$3.20

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C12	# Servings Beef Tips	2.344640434	0	0.71	0.014680851	0.40516129
D12	# Servings Gravy	1.172320217	0	0.41	4.42	0.006946309
E12	# Servings Peas	4	0	0.22	0.009501357	0.034084125
F12	# Servings Carrots	0	0.012668476	0.31	1E+30	0.012668476
G12	# Servings Dinner Roll	0.691994573	0	0.25	0.025875	0.1768

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
H19	Min. Calories LHS	280	0.005997286	280	40	17.9501385
H20	Max. Calories LHS	280	0	320	1E+30	40
H21	Calories from Fat LHS	83.12075984	0	84	1E+30	0.879240163
H22	Vitamin A LHS	600	0.000227227	600	98.70967742	16.94856146
H23	Vitamin C LHS	80	0	10	70	1E+30
H24	Protein LHS	30	0.046092266	30	0.6	3.735294118
H25	Min. Beef LHS	2.344640434	0	2	0.344640434	1E+30
H26	Min. Gravy LHS	1.17232	0.005617368	1.17232	0.90070922	1.44966443

(a) **(0.5 Points)** Which foods are **not** used in the final solution?

(b) **(0.5 Points)** What is the optimal objective function value?

(c) **(0.5 Points)** What constraints are binding?

(d) **(0.5 Points)** In one sentence, interpret the reduced cost for **servings of carrots**.

(e) **(1 Point)** What would the new value of the objective function be if the **Vitamin C** R.H. constraint side became 15?

(f) **(1 Point)** What would the new value of the objective function be if the **Protein** R.H. constraint side became 26?

(g) **(1 Point)** What would the new value of the objective function be if the **Min Calories** R.H. constraint side became 320?