Total possible points: 60

1. Linear Optimization Model (60 points in total)

Kelson Sporting Equipment, Inc., makes two types of baseball gloves: a regular model and a catcher's model. The firm has 900 hours of production time available in its cutting and sewing department, 300 hours available in its finishing department, and 100 hours available in its packaging and shipping department. The production time requirements and the profit contribution per glove are given in the following table:

	Production Time (hours)			
Model	Cutting and Sewing	Finishing	Packaging and Shipping	Profit/Glove
Regular model	1	½	⅛	$5
Catcher's model	½	⅓	¼	$8

Assuming that the company is interested in **maximizing the total profit contribution**, answer the following questions.

1.1 What is the linear programming model for this problem expressed in the mathematical form? Write down the entire mathematical model in the following space including the explicit and implicit constraint inequalities. Let R = number of units of regular model, and C = number of units of catcher's model. (15 points)

Let R = number of units of regular model.
C = number of units of catcher's model.

Max	5R	+	8C			
s.t.						
	1R	+	3/2 C	≤	900	Cutting and sewing
	1/2 R	+	1/3 C	≤	300	Finishing
	1/8 R	+	1/4 C	≤	100	Packing and Shipping
			R, C	≥	0	Nonnegativity

1.2 Develop a spreadsheet model by completing the missing parts indicated by the bordered cells **except the two shaded cells** in the provided ***Kelson.xlsx*** file and find the optimal solution using Excel Solver. Generate an **answer report** on a separate worksheet in the same Excel file. According to the optimal model result or the answer report, how many of each glove model should Kelson manufacture to achieve the optimal solution? (25 points)

See the posted supplementary Excel file **Kelson_solution.xlsx** for the spreadsheet model (template) and the answer report. Kelson should manufacture 500 regular baseball gloves and 150 catcher's baseball gloves to achieve the optimal solution.

1.3 What is the total profit contribution Kelson can earn with the optimal production quantities? How many hours of production time will be scheduled in each department? (5 points)

The total profit contribution is $3,700 in the optimal solution The actual hours of production time that will be scheduled in each department is: 725 hours for Cutting and Sewing, 300 hours for Finishing, and 100 hours for Packaging and Shipping.

1.4 According to the answer report, among the three explicit constraints (Hours Available for Cutting and Sewing, Hours Available for Finishing, and Hours Available for Packaging and Shipping), which constrain(s) are binding? What is the slack time in each department? (5 points)

In the optimal solution, when a constraint's left hand side value equals its right hand side value, that constraint is binding. There are two binding constraints: the Finishing constraint, and the Packaging and Shipping constraint, and hence their slacks are zero. For Cutting and Sewing, since it is non-binding, the slack is 900 – 725 = 175 (hours).

1.5 Generate a **sensitivity report** this time on a separate worksheet in the same Excel file. What are the three explicit constraints' shadow prices according to the sensitivity report. What does each shadow price mean for each corresponding constraint? (10 points)

See **Kelson_solution.xlsx** for the sensitivity report. The shadow price for the Cutting and Sewing constraint is $0 which means when this non-binding constraint's right hand side value (900 hours) increases by 1 hour, the optimal objective function value doesn't change.

The shadow price for the Finishing constraint is $3 which means when this binding constraint's right hand side value (300 hours) increases by 1 hour, the optimal objective function value will increase by $3.

The shadow price for the Packaging and Shipping constraint is $28 which means when this binding constraint's right hand side value (100 hours) increases by 1 hour, the optimal objective function value will increase by $28.