General Instructions for Students

1. The problem sets given in this handout are taken from old exams.
2. Exercises should NOT submitted (they will not be graded). However,
3. The best, and perhaps the only, way to ensure that you understand the material taught in class is to solve the exercises under "exam conditions" and only then check the proposed solution.
4. Solutions to all problems can be downloaded as a separate file.
5. Another advantage of solving these exercises is that they provide the best preparation for the exams. Most exam questions will be based on variations of these exercises.

Set # 1: Basic Observations

Answer all 5 True/False questions.

(A) The share of agricultural products in world merchandize exports has been rising since 1950.

(B) Among all internationally traded services, world exports of transport services have grown the fastest during the past 20 years.

(C) Agricultural products constitute the largest share in U.S. exports.

(D) Since World War II, the average annual percentage growth rate of world exports was lower than the world real GNP growth rate.

(E) In dollar terms, U.S. Imports and exports of computers and electronics are higher than any other core manufacturing industry.

Set # 2: The Ricardian Model

(A) Consider a world with two countries A and B and two goods X and Y. Each good is produced using labor only. Both countries are endowed with the same about of labor. That is, $L^A = L^B = 1000$.

The following matrix provides the amount of labor needed to produced one unit of each good in each country:

	X	Y
A	5	2
B	2	2

Suppose that all consumers have the same preferences, and that they view both goods as perfect complements. Hence, they will always consume one unit of X for every one unit of Y. Formally, $U(x,y) = \min\{x,y\}$.

Answer the following questions:

(i) Draw the production possibility frontier for each country.

(ii) How much will be produced and consumed in each country under autarky? Show your work on the graphs.

(iii) Draw the world production possibility frontier.

(iv) Calculate the total amount of good X and good Y that are consumed in the world.

(v) Assume that $p_X/p_Y = 1$. Calculate the production level of X and Y in *each* country (under free trade).

(vi) What are the consumption levels in each country under free trade.

(vii) Answer all the above assuming that all the consumers consume two units of X for each unit of Y. Formally, consumers' utility function is given by $U(x,y) = \min\{x, 2y\}$. *Remark: Now you should not assume that $p_X/p_Y = 1$. Instead, you should be able to derive/infer p_X/p_Y by observing the slope of the world PPF at the world production/consumption point.*

(B) In a world with two goods denoted by X and Y, and two countries denoted by A and B, there is only one factor of production, called labor. Denote by L^A the labor endowment to country A, and by L^B the labor endowment to country B. Under free trade, country A exports good X to country B. Now suppose that the labor endowment to country B has doubled and is now given by $2L^B$, while the labor endowment to country A remains unchanged. Then, it is possible that the labor increase in country B will increase the welfare of country A.

(C) $L^A = L^B = 1200$, and

	X	Y
A	1	3
B	∞	2

and $U(x,y) \equiv \min\{x,y\}$.

Answer the following questions:

(i) Draw the world production possibility frontier.

(ii) Calculate the total amount of good X and good Y that are consumed in the world.

(iii) Calculate the world free trade prices p_X/p_Y.

(iv) Calculate the production level of X and Y in *each* country (under free trade).

(v) What are the consumption levels in each country under free trade.

(D) Consider a world with three countries A, B, and C, and two goods X and Y. Each good is produced using labor only. Countries A and B are endowed with the same about of labor, that is, $L^A = L^B = 1200$. However, Country C's endowment of labor is $L^C = 1000$. The following matrix provides the amount of labor needed to produced one unit of each good in each country:

	X	Y
A	4	3
B	3	4
C	2	2

Suppose that all consumers have the same preferences, and that they view both goods as perfect complements. Hence, they will always consume one unit of X for every one unit of Y. Formally, $U(x, y) \equiv \min\{x, y\}$.

Solve the following problems:

(i) Draw the world production possibility frontier.

(ii) Calculate the total amount of good X and good Y that are consumed in the world.

(iii) Calculate the world free trade prices p_X/p_Y, and explain which countries gain from trade.

(iv) Calculate the production level of X and Y in *each* country (under free trade).

(v) What are the consumption levels in each country under free trade.

(E) Consider freely trading countries A and B, in a Ricardian world where labor is a single factor in producing goods X and Y, and where all consumers consume one unit of X *for every* unit of Y. Suppose that the *marginal productivity* of each worker in each country and each industry is given

	X	Y
A	1	$1/2$
B	$1/2$	1

Initially, the population size in country A is $L^A = 2$ and the population size of country B is $L^B = 6$, but due to an extremely high natural population growth rate in country A and virtually no population growth in country B, country A is expected to have a population of $\tilde{L}^A = 12$ five years from now.

True or False? Prove your answer! Residents of country A will be better off five years from now than they are now. Prove by drawing the relevant graph(s).

(F) Consider trade between the US and Malawi, where

	Steel	Tobacco
US	4	10
Malawi	40	20

Solve the following problems:

(i) Answer True of False and explain: Under free trade, unequal exchange occurs at every possible equilibrium international price ratio (p_t/p_s).

(ii) Answer True of False and explain: By the Factor Price Equalization Theorem, under free trade the US wage rate will be equal to the wage rate in Malawi. *Note*: You will not be able to answer this question until after you have completed learning the H–O Model.

(G) Consider a world with 2 countries A and B and 2 goods X and Y. There is no production, however, countries are simply endowed with final goods. Country A is endowed with 500 units of X and no Y. Country B is endowed with 1500 units of Y and no X. In each country there is one consumer with a Cobb-Douglas utility function given by $U(x,y) = x \cdot y$. Solve the following problems:

(i) Draw the world PPF and compute the equilibrium price ratio p_X/p_Y under free trade between the two countries.

(ii) Compute the consumption level in country A and country B under free trade.

(H) Consider trade between Canada and the U.S. in two goods: Machines (M) and wood (W). Labor is the only input in production. The U.S. is endowed with $L^U = 300$ units of labor, whereas Canada with $L^C = 30$ units of labor. The labor requirement matrix is given by

Country\Good	Wood	Machines	L^j
U.S.	$\ell_W^U = 6$	$\ell_M^U = 3$	$L^U = 300$
Canada	$\ell_W^C = 1$	$\ell_M^C = 1$	$L^C = 30$

All consumers in the world have identical preferences represented by the Cobb-Douglas utility function $U(W,M) = W \cdot M$. Solve the following problems:

(i) Draw U.S. PPF (label good M on the horizontal axis), and compute the equilibrium price ratio $(p_M/p_W)^U$ and consumption levels M_c^U and W_c^U in the U.S. under autarky.

(ii) Draw Canada's PPF (label good M on the horizontal axis), and compute the equilibrium price ratio $(p_M/p_W)^C$ and consumption levels M_c^C and W_c^C in Canada under autarky.

(iii) Draw the world PPF and compute the equilibrium world price ratio $(p_M/p_W)^W$, and the production levels *in each country* under free trade.

(iv) Compute the equilibrium consumption levels *in each country* under free trade.

(v) Compute the equilibrium wage rate ratio w^U/w^C under free trade. Explain the differences in wage rates between these countries.

(I) Consider a world with three countries A, B, and C, and two goods X and Y. Each good is produced using labor only. Countries A, B, and C are endowed with the same about of labor, that is, $L^A = L^B = L^C = 12$. The following matrix provides the amount of labor needed to produced one unit of each good in each country:

	X	Y
A	6	6
B	2	1
C	3	6

Suppose that all consumers have the same preferences, and that they view both goods as perfect complements. Hence, they will always consume one unit of X for every one unit of Y. Formally, $U(x,y) \equiv \min\{x,y\}$. Solve the following problems:

(i) Draw the world PPF and compute the equilibrium price ratio $(p_X/p_Y)^W$ production levels of goods X and Y *in each country* under free trade.

(ii) Compute the amount of good X imported or exported by country B.

Set # 3: Extended Ricardian Model: Tariffs and Transportation Costs

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(A) Consider trade between Austria and Belgium (countries A and B) with two goods (X and Y). Labor is the only factor of production. The labor-requirement for production of each good in each country is:

	X	Y
A	5	10
B	20	10

Answer the following questions:

(i) Suppose that you know that there is free trade between the two countries. Compute the range of possible international price ratios under free trade. That is, compute the lowest and highest $(p_X/p_Y)^W$ possible under free trade. Indicate which country exports X and which country exports Y by drawing each country's PPF.

(ii) Answer the above question assuming that country A imposes a 20% tariff ($t_A = 0.2$) on its import good, and that country B imposes a 50% tariff ($t_B = 0.5$) on its import good.

(iii) Suppose tariffs are no longer imposed on any good. Instead, assume that trade between the countries generates "iceberg" type of transportation cost. Formally, only a fraction of $g = 0.75$ of each export shipment arrives to its destination. Compute the range of possible international price ratios under free trade. That is, compute the lowest and highest $(p_X/p_Y)^W$ possible under free trade.

(B) Brazil has L units of labor, which is the sole input in the production of two goods: Food (denote by F) and cars (denoted by C). In Brazil, $\ell_F = 1$ units of labor are required to produce 1 unit of F, whereas $\ell_C = 3$ units of labor are required to produce 1 unit of C, Suppose that the world price ratio $(p_C/p_F)^W$ is fixed (Brazil takes it as given). Solve the following problems:

(i) Compute the range of world price ratios $(p_C/p_F)^W$ under which Brazil imports cars (and exports food). Also compute the ratios under which Brazil imports food (and exports cars).

(ii) Answer the previous question assuming now that the Brazilian government imposes an import tariff rate of $t = 0.5$ (that is, a 50% ad valorem tariff on imports).

Set # 4: Concave Production Possibility Curves

(A) In this problem, we would like to confirm the Theorem concerning the relationship between the ratio of #factors to the #good and the shape of the PPF under CRS. Suppose that goods X and Y are produced with labor only. Suppose that there are two types of labor: 10 young workers and 8 old workers. (i) Each young can produce 2 units of X, **or** 1 unit of Y. (ii) Each old can produce 1 unit of X, **or** 1 unit of Y.

Assuming that both types of labor are perfectly divisible, draw the country's PPF.

(B) Consider a single economy, with two industries producing goods X and Y. Each good is produced using labor and capital. Denote by ℓ_x the amount of labor employed in the X-industry, and by ℓ_y the amount of labor employed in the Y-industry. Similar subscript notation is used for k_x and k_y. The production function for good X is given by $X = f(\ell_x, k_x)$ and for good Y by $Y = g(\ell_y, k_y)$. Finally, factor prices are denoted by W (price of labor) and R (price of capital).

Prove whether the following production functions exhibit increasing returns to scale (IRS), constant returns to scale (CRS), or decreasing returns to scale (DRS):

(i) $x = (\ell_x)^{1/2}(k_x)^2$.

(ii) $x = \ell_x + k_x$.

(iii) $x = (\ell_x)^2 + (k_x)^2$.

(iv) $x = (\ell_x)^{1/2} + (k_x)^{1/2}$.

(v) $x \equiv (\ell_x)^{0.6}(k_x)^{0.4}$

(C) The production possibility frontier (PPF) of a small island in Cental America is given by $y = 240 - x^2$, where X measures coconuts and Y measures oranges. The utility function of local residents is $U(x, y) = x \cdot y^2$. This island is small in the sense that it cannot affect world prices, which are given by $p_X = 10$ and $p_Y = 1$. Answer the following questions:

(i) Compute the island's consumption levels of goods X and Y under free trade.

(ii) A military cue has brought General Oto-Turkey into power. The General announced that free trade is immoral and she ordered to close the economy so that there is no connection to the outside world. Compute the consumption level of this island's residents under autarky.

(iii) Draw the island's PPF, trade line under free trade, and indifference curves, consumption and production points under autarky.

(D) The PPF of a small island in South America is given by $x^2 + 2y = 12$, where X denotes coconuts and Y denotes oranges. All residents in this island have identical preferences represented by the utility function $U = x + y$. The island is small in the sense that its trade volume does not affect world prices, which are given by $p_X^W = \$2$ and $p_Y^W = \$1$.

Compute the volume of export and import of this island.

(E) Solve the above problem assuming that the PPF is $x^2 + 2y = 12$ and the utility function is $U = x^2 y$.

(F) The production possibility frontier of a small island in Central America is given by

$$y = 12 - \frac{x^2}{2},$$

where X and Y are the only producible and consumable products on this island. Consumers' preferences for the two goods are given by the Cobb-Douglas utility function $U(x, y) = x \cdot y$.

The island is small, and therefore cannot influence world prices which are given by $p_X^w = 8$ and $p_Y^w = 2$. Compute the island's import level of good Y under free trade.

Set # 5: The Heckscher-Ohlin Model

(A) There are two countries: the US and Europe. There are two goods: corn and clothes, both goods are produced by two factors called labor (L) and land (T). The following matrix describes the factors endowments to each country. The data was collected from my 1982 ($4.95) Almanac:

	Land (mil. sq. miles)	Labor (pop. mil.)
Europe	4	690
US	3.6	230

(i) True/False: Prove your answer using the definition: *"The US is land abundant relative to labor compared with Europe."*

(ii) Suppose that the clothes industry is labor intensive relative to land compared to the corn industry. True/False: Prove your answer using the H-O Theorem: *"The US has a comparative advantage over Europe in corn relative to clothes."*

(B) TRUE OR FALSE, You must PROVE your answer! Assume a world economy satisfying the H-O assumptions. A small increase in the capital stock of the labor-abundant country will cause a reduction in the export level of the capital-abundant country.

(C) TRUE OR FALSE, You must PROVE your answer! Europe is labor abundant and the US is land abundant. Assume that all the H-O assumptions are satisfied in this two country world economy. When Europe and the US move from autarky to free trade, land owners in the US will experience an increase in their real income.

(D) TRUE OR FALSE, You must PROVE your answer! When Europe and the US (fully described in question (c), are freely trading in goods (while producing a positive amount of each good), labor in Europe will not have an incentive to immigrate to the US.

(E) TRUE OR FALSE, You must PROVE your answer! In a 2-country, 2-goods (X and Y), 2-factors (Land and Labor) world, under free trade, country A exports labor-intensive manufactured goods and imports land-intensive food products. Then, if the world moves from an autarky regime to free trade, land owners in country A would experience a rise in their real income.

(F) Consider a world with 2 countries: A and B; 2 goods: Computers (C) and food (F); and 2 factors of productions: Labor (L) and capital (K).

Country A is endowed with $L^A = 10$ units of labor and $K^A = 5$ units of capital. Country B is endowed with $L^B = 8$ units of labor and $K^B = 8$ units of capital. Labor and capital are mobile between industries in the same countries, but are internationally immobile between countries.

All countries have identical technologies for producing computers and food, which are given by the constant returns to scale production functions:

$$C = L_C^{\frac{2}{3}} \cdot K_C^{\frac{1}{3}} \quad \text{and} \quad F = L_F^{\frac{1}{2}} \cdot K_F^{\frac{1}{2}}$$

Answer the following questions.

(i) Which good is capital intensive, and which good is labor intensive?

(ii) Which country is labor abundant and which country is capital abundant? Using the prediction made by the Heckscher-Ohlin Theorem (H-O) conclude which country exports food and which exports computers under free trade.

(G) Let the production functions for X and Y be defined by

$$x \equiv (\ell_x)^{0.6}(k_x)^{0.4} \text{ and } y \equiv (\ell_y)^{0.2}(k_x)^{0.8}$$

(i) For given factor prices W and R, calculate the capital/labor ratio employed in industry X and in industry Y. That is, calculate k_x/ℓ_x and k_y/ℓ_y as functions of W/R. Show your work.

(ii) On the space ℓ_x-k_x and on the space ℓ_y-k_y (label labor on the horizontal axis) draw iso-cost lines and iso-quants, and illustrate the capital/labor ratio used in each industry by drawing an auxiliary ray from the origin.

(iii) Which industry is capital intensive and which industry is labor intensive. Use the definition of intensity to justify your answer.

(H) State Leontief's Paradox. Make sure that you explain which theorem was tested by Leontief.

Discuss at least three explanations that were given to this paradox over the years. Discuss how these explanations reconcile the paradox with the theorem that was tested by Leontief.

Set # 6: The Specific-factors Model

(A) Suppose that the US produces two goods: Corn and Machines. Both goods are produced with the help of labor and industry specific capital. That is, assume that labor is perfectly mobile between industries, and is traded in a competitive labor market, however, capital is designed to be industry specific and is therefore immobile between the industries.

How a 10-percent increase in the international price of corn would affect the wage rate, rent on corn-specific capital and the rent machine-specific capital? Prove your answer!

(B) Consider an open competitive economy with two factors of production (labor and capital) producing and consuming two goods (X and Y). Assume that capital is perfectly mobile between the two industries. Then,

True or False? Use graphs to support your answers! An increase in the international price of good X will decrease the production of good Y if labor is perfectly mobile between industries, but will increase the production of good Y in case labor is immobile between industries.

(C) The United States produces 2 goods: A consumption good (C) and financial services (F). We make the following assumptions:

- Good M is produced from 2 factors of production: Unskilled labor and capital.
- Good F is produced from 2 factors of production: Skilled labor and capital.
- Both types of labor are immobile between industry.
- Capital is perfectly mobile between the 2 industries.

Solve the following problems:

(i) Due to an increase in the international demand for financial services, the international price of financial services p^F has increased. How would this increase in p^F affect the wage rate of skilled and unskilled workers and the rental on capital?

(ii) Answer the above question assuming that as a result of immigration the U.S. experiences an increase in the amount of unskilled labor (instead of assuming an increase in p^F).

(D) In a small country there are 2 sectors: Agriculture (A), and banking (B). In this country there are 3 factors of production: Labor (perfectly mobile between sectors), land (D) which is specific to sector A, and capital (K) specific to sector B. Denote the price of labor (wage) by W, but R_D the rent on land, and by R_K the rent/price of capital.

Let p_A and p_B denote the international prices of these goods. Now suppose that the country had to give up some land (either because of international pressure or because of losing a war). Analyze what happens to factor prices W, R_D, and R_K, both in nominal and real terms.

(E) A country trades and produces two goods: Financial services (F) and cars (C). The international price of a financial service is denoted by p_F. The international price of a car is denoted by and p_C.

Financial services are produced with capital and specific labor (labor skilled in producing F only which cannot be employed in the car industry).

Cars are produced with capital and specific labor (labor skilled in producing C only which cannot be employed in the financial sector).

Let K_F denote the amount of capital employed by the financial sector and K_C the amount of capital employed in the car industry. The country is endowed with $\bar{K}$ units of capital, so full employment of capital implies $K_F + K_C = \bar{K}$.

The country is endowed with $\bar{L}_F$ units F-specific labor and with $\bar{L}_C$ units of C-specific labor.

Let w_F denote the wage rate paid to workers in the financial sector and w_C denote the wage rate paid by the car industry to C-specific labor. The rental on the mobile factor, capital, is denoted by R.

Suppose now that it becomes clear that free trade leads to a 10% reduction in the price of cars (p_C declines). Solve the following problems:

(i) Using a graph of the capital market analyze how the decline in p_C affects the amount of capital employed in each industry (K_F and K_C).

(ii) Analyze how the reduction in p_C affects the nominal rent on capital R, and the real rents, R/p_F and R/p_C. Will capital owners lobby for or against free trade.

(iii) Analyze how the reduction in p_C affects the nominal wage rate in the car industry, w_C, as well as the real wages w_C/p_F and w_C/p_C. Will automobile labor union lobby for or against free trade?

(iv) Analyze how the reduction in p_C affects the nominal wage rate in the financial sector, w_F, as well as the real wages w_F/p_F and w_F/p_C. Will workers in the financial sector lobby for or against free trade?

Set # 7: Differentiated Products Under IRS

(A) Suppose that all consumers consume only two goods, good 1 and good 2, and have a CES utility function given by

$$U(x_1, x_2) \equiv (x_1)^{\frac{1}{3}} + (x_2)^{\frac{1}{3}}, \tag{1}$$

(i) Label x_2 on the vertical axis, and x_1 on the horizontal axis, and draw the indifference curve yielding a utility of $\bar{U} = 2$ (using a red pen).

(ii) Write down the "tangency condition" necessary for having a consumer choosing his or her utility maximizing bundle, and calculate the demand-price elasticity of goods 1 and 2. Is the demand for good 1 elastic or inelastic?

(B) Suppose now that the consumers' utility function is given by

$$U(x_1, x_2) \equiv (x_1)^{\frac{1}{2}} + (x_2)^{\frac{1}{2}}, \tag{2}$$

where x_1 denotes the consumption level of good 1, and x_2 the consumption level of good 2.

(i) On the same graph, draw the indifference curve yielding a utility of $\bar{U} = 2$ (using a blue pen).[1]

(ii) Write down the "tangency condition" necessary for having a consumer choosing his or her utility maximizing bundle, and calculate the demand-price elasticity of goods 1 and 2. Is the demand for good 1 elastic or inelastic?

(C) Suppose now that the consumers' utility function is given by

$$U(x_1, x_2) \equiv x_1 + x_2, \tag{3}$$

(i) On the same graph, draw the indifference curves yielding a utility of $\bar{U} = 2$ (using a black pen).

[1] An indifference is the set of all consumption bundles yielding a constant utility $\bar{U}$.

(ii) Can you guess what is the demand-price elasticity for this case ?

(D) Based on your results, comparing the utility functions (1), (2) and (3) answer the following questions:

(i) Which utility function exhibits the highest degree of brand substitution? Which exhibits the lowest degree of substitution?

(ii) Which utility function yields the most elastic demand for good 1, which yields the most inelastic demand function.

(iii) Is a higher degree of substitution associated with more elastic or inelastic demand? Explain.

(E) Suppose now that consumers have a utility function given by

$$U(x_1, x_2) \equiv (x_1)^{\alpha} + (x_2)^{\alpha}, \quad 0 < \alpha < 1. \tag{4}$$

(i) Does a higher α reflect a higher or lower degree of brand substitution. Explain!

(ii) Does a higher α generate a more elastic or less elastic demand functions for goods 1 and 2?

(F) Consider one economy with L units of labor which is the sole input in production. All consumers have a CES utility function given by

$$U(x_1, x_2) \equiv \sum_{i=1}^{n} (x_i)^{\frac{1}{3}},$$

where x_i is the consumption level of brand i, $i = 1, 2, \ldots, n$.

Each brand is produced by a single firm under an IRS production technology. Each firm incurs a fixed cost of $F > 0$ and in addition, a cost of $c > 0$ per unit produced.

(i) Given that firm i is a monopoly on brand i, write down the firm's profit maximizing first-order condition (marginal revenue equals marginal cost) and conclude what price will be charged by the firm, p_i.

(ii) Using the freedom of entry and exit condition (also known as the zero-profit condition), calculate the output level of each firm, x_i.

(iii) Using the full-employment condition, calculate the number of brands, n, produced in this economy (as a function of the parameters F and L).

(iv) Conclude whether the equilibrium number of brands increases or decreases with the fixed cost parameter, F, and with the labor endowment parameter, L.

(v) Suppose that $F = 1$ and $c = 4$. Also suppose that there are two countries (called Home and Foreign), identical in all respects, where each country is endowed with 30 units of labor. That is, $L^H = L^F = 30$. How many brands are produced in each country under *autarky*?

(vi) Calculate the autarkic equilibrium utility level of the representative consumer in each country.

(vii) How many brands are consumed by each consumer under *free trade*? Prove your result!

(viii) Calculate the free-trade equilibrium utility level of a representative consumer in each country and conclude whether the countries gain from trade. *Hint:* $\sqrt[3]{2} = 1.26$.

(G) Consider one autarkic economy with $L = 4000$ units of labor which is the sole input in production. All consumers have a CES utility function given by

$$U(x_1, x_2, \ldots, x_n) \equiv \sum_{i=1}^{n} (x_i)^{\frac{1}{4}},$$

where x_i is the consumption level of brand i, $i = 1, 2, \ldots, n$.

Each brand is produced by a single firm under an IRS production technology. Each firm incurs a fixed cost of $F = 300$ and in addition, a cost of $c = 1$ per unit produced. Solve the following problems:

(i) Given that firm i is a monopoly on brand i, write down the firm's profit maximizing first-order condition (marginal revenue equals marginal cost) and conclude what price will be charged by the firm, p_i.

(ii) Using the freedom of entry and exit condition (also known as the zero-profit condition), calculate the output level of each firm, x_i.

(iii) Using the full-employment condition, calculate the number of brands, n, produced in this economy.

(iv) Suppose now that there is free trade among 10 countries, each is identical to the economy described above. Calculate the utility level of each country under *free trade*.

(H) Two countries identical in their factor endowment, production technologies, and consumer tastes cannot gain from trading with each other. True or false? Prove!

(I) Consider a single autarkic economy with $L = 2400$ units of labor which is the sole input in production. All consumers have a CES utility function given by

$$U(q_1, q_2, \ldots, q_n) \equiv \sum_{i=1}^{n} (q_i)^{\frac{1}{2}} = \sum_{i=1}^{n} \sqrt{q_i},$$

where q_i is the consumption level of brand i, $i = 1, 2, \ldots, n$.

Each brand is produced by a single firm under an IRS production technology. Each firm incurs a fixed cost of $F = 120$ and in addition, a cost of $c = 2$ per unit produced. That is, the total cost of brand i producing firm is $TC_i(q_i) = 120 + 2q_i$. Solve the following problems:

(i) Given that firm i is a monopoly on brand i, write down the firm's profit maximizing first-order condition (marginal revenue equals marginal cost) and conclude what price will be charged by the firm, p_i.

(ii) Using the freedom of entry and exit condition (also known as the zero-profit condition), calculate the output level of each firm, q_i.

(iii) Using the full-employment condition, calculate the number of brands, n, produced in this economy.

(iv) Calculate the country's utility level under *autarky*.

(v) Suppose now that there is free trade among 3 countries, each is identical to the economy described above. Calculate the utility level of each country under *free trade*.

Set # 8: Trade Restrictions: A partial equilibrium approach

(A) Suppose that country A's inverse demand for good Y is given by $p = \frac{16}{y^d}$. Also, suppose that the inverse supply function of domestic producers is given by $p = y^s$. Finally, suppose that country A is 'small' and can buy or sell any amount of good Y for a world price given by $p_Y^W = 1$. Answer the following questions:

(i) Draw the demand and the domestic and world supply functions.

(ii) Calculate the prohibitive specific import tariff level.

(iii) Calculate the prohibitive ad-valorem import tariff level.

(iv) Calculate the government's revenue levels for specific tariff levels given by $t_s = 1, 2, 3,$ and 4. Show all your work!

(v) Conclude what is the specific tariff level that maximizes government's revenue.

(B) Suppose that country A's demand for good Y is given by $y^d = 12 - p$. Also, suppose that the supply function of domestic producers is given by $y^s = p$. Finally, suppose that country A is "small" and can buy or sell any amount of good Y for a world price given by $p_Y^W = 2$. Answer the following questions

(i) Calculate the prohibitive specific import tariff rate.

(ii) Calculate the prohibitive ad-valorem import tariff rate.

(iii) What is the specific tariff rate that maximizes government's revenue?

(C) Suppose that country A's inverse demand for good Y is given by $p = 12 - 2y^d$. Also, suppose that the inverse supply function of domestic producers is given by $p = 2y^s$. Finally suppose that country A is 'small' and therefore can buy or sell any amount of good Y for a world price given by $p_Y^W = 2$.

(i) Calculate the prohibitive specific import tariff level.

(ii) Calculate the prohibitive ad-valorem import tariff level.

(iii) Calculate the tariff rate that maximizes the revenue collected by the government.

(D) Domestic demand is given by $p = 12 - y^d$. Domestic supply is given by $p = 2y^s$. This is economy is small in the sense that it can sell or buy each unit of this good at a fixed international price given by $p^w = 1$.

Under pressure by the domestic producer, the government decides to impose an *import quota* of 3 units of this good. That is, the government limits the import of Y to 3 units only.

Compute the equilibrium domestic price of Y before and after the imposition of this import quota.

(E) Domestic demand is given by $p = 120 - y^d$. Domestic supply is given by $p = 60 + y^s$. This is economy is small in the sense that it can sell or buy each unit of this good at a fixed world price given by $p^w = \$20$. Solve the following problems:

(i) Compute the specific import tariff rate $\bar{t}$ that maximizes government's revenue. Hint: You should distinguish among the following 3 cases: $p^W + t > \$60$, $p^W + t < \$60$, and $p^W + t = \$60$.

(ii) Suppose that the government has cancelled the tariff. Instead, the government implements an import quota of $I = 40$ units. Compute the price and the quantity produced in the domestic market.

(iii) Solve the previous problem assuming $I = 80$ (instead of $I = 40$ units).

(F) Domestic demand is given by $p = 120 - 2y^d$. Domestic supply is given by $p = 60 + y^s$. This is economy is small in the sense that it can sell or buy each unit of this good at a fixed world price given by $p^w = \$20$. Solve the following problems:

(i) Compute the specific import tariff rate $\bar{t}$ that maximizes government's revenue. Hint: You should distinguish among the following 3 cases: $p^W + t > \$60$, $p^W + t < \$60$, and $p^W + t = \$60$.

(ii) Compute social welfare level under the tariff rate you computed in the previous part of this problem and compare it to social welfare when no tariff is imposed ($t = 0$). Conclude whether this tariff improves or reduces social welfare.

(G) Chewata (a small country) can import chewing gum at a given world price of $p_W = 30$ per package. The domestic inverse demand function for chewing gum packages is $p = 120 - y^d$.

In Chewata there is one producer of chewing gum whose inverse supply function is given by $p = 80 + y^s$. Solve the following problems.

(i) Let t_s denote the specific import tariff imposed on imported chewing gum. (i) Compute the tariff level which maximizes government's revenue. (ii) Compute the amount of revenue the government collects under this tariff.

(ii) Instead of levying an import tariff the government decided to impose an import quota of $\bar{I} = 20$ packages. Compute the equilibrium domestic price and the revenue collected by the government from selling 20 import licenses.

(iii) Suppose now that the government abolishes all import tariffs and quotas. Instead, the government subsidizes domestic production by paying domestic producers a specific subsidy of $s = \$70$ per unit produced. Compute (i) the number units produced by domestic firms under this subsidy, (ii) how many units are imported, and (iii) compute the total subsidy cost borne by the government.

Set # 9: Trade Restrictions: A general equilibrium approach

(A) Using the appropriate graph, describe a world economy protection game where the government of country A is restricted to levying an import tariff, while the government of country B is restricted to imposing an import quota on its imported good. Will this protection game result in a complete elimination of world trade? Prove!

(B) Using the appropriate graph, describe a world economy protection game where the government of country A is restricted to imposing an export quota (on its exported good), while the government of country B is restricted to imposing an import quota on its imported good. Will this protection game result in a complete elimination of world trade? Prove!

(C) Suppose that country A is a 'small' country. Then, when country A imposes a tariff on its import good, the domestic price consumers pay for the import good (in terms of the export good) will always rise. True of false? Prove!

(D) Suppose that the world consists of two (large) countries (A and B), two goods, and two factors of production (called *labor* and *land*). Also, suppose that the two countries trade according to the H-O Theorem, so that in equilibrium country A exports the land-intensive good. Then, when country A imposes an import tariff on the labor-intensive good, the rent on land in country A will increase relative to the domestic prices of all goods in country A. True of false? Prove! (Note: Assume that Metzler's Paradox does not occur).

(E) Suppose that country A is restricted to imposing an import quota only, and that country B is restricted to imposing an export quota only. Then, a protection war game where country A starts with the imposition of its optimal import quota, followed by country B imposing its optimal export quota, and so on..., will eliminate all trade between the countries. True or false? Prove!

(F) A tariff war between two countries must reduce the welfare of both countries. True or false? Prove!

(G) The optimal tariff rate for a small country is strictly positive. True or false? Prove!

(H) An imposition of an optimal export quota by one country leads to higher terms of trade compared with the imposition of the optimal tariff by the same country, as long as the other country does not retaliate. True or false? Prove!

(I) Suppose that the world consists of two countries initially freely trading in two goods (according to the H-O assumptions). Also, suppose that a quota war suddenly erupts and that in this war the countries are restricted to using export quotas only. That is, suppose that countries move in sequence, more precisely, country A is the first to set its optimal export quota, followed by country B setting its export quota, and so on.

True or false? Prove! The country that initiates the export quota war (country A) can gain from this war.

(J) The US would be better off by negotiating a VER of cars with Japan rather than adhering to its free trade policy (i.e, not imposing or negotiating any protective policy). True or false? Prove your answer using the appropriate model.

(K) Suppose that there are only two countries, A and B, that trade according to the Heckscher-Ohlin assumptions (i.e., CRS production technologies, perfect competition, etc.). Now suppose that both countries are engaged in a tariff war. Then, if one country gains from this war, the other country must lose.
True or false? Explain and prove using the relevant figure.

(L) Consider a world with 2 countries: A and B, 2 goods: X and Y, and 2 factor of production: capital (K), and labor (L). Country A is labor abundant. Good X is capital intensive. Under free trade both countries trade according to the H-O model.

Country A considers three possible protection policies: Optimal tariff on Y imports, optimal import quota on Y, and optimal export quota on X. Using 3 separate graphs, determine and compare how each protection measure affects A's terms-of-trade p_X/p_Y, local price ratio p_X^A/p_Y^A, import quantity y^A, export level x^A, and government revenue G^A.

Set # 10: Subsidies to R&D

(A) Table 1 exhibits the profit levels of Airbus and Boeing under the four possible market outcomes. Answer the following questions:

(i) Calculate the minimal subsidy to Airbus that will ensure that Airbus will develop the mega-carrier. Explain!

		AIRBUS	
		Produce	Don't Produce
BOEING	Produce	-10 -10	50 0
	Don't Produce	0 50	0 0

Table 1: Profits of Boeing and Airbus under no gov't intervention

(ii) Suppose that the EC provides Airbus with 15 units of money as a subsidy. Which subsidy by the US government to Boeing would guarantee that Boeing will develop this mega-carrier?

(iii) Suppose that the EC provides Airbus with 15 units of money as a subsidy. Is there any level of subsidy given by the US government that would deter Airbus from developing this airplane.

(iv) From you answer to the previous question, conclude whether the world benefits by having both governments subsidizing their own aircraft manufacturing firms. Explain!

(B) Suppose that there only two civilian aircraft manufacturers in the entire world, and that the world consists of two countries, the US and the EC. Suppose further that each firm is a profit maximizer and has a binary choice: develop (and produce) or Don't develop (and don't produce). The following table demonstrates the profit levels of each firm under the four possible market outcomes. Suppose that the EC government promises Airbus to 'contribute'

		AIRBUS	
		Produce	Don't Produce
BOEING	Produce	-10 -15	50 0
	Don't Produce	0 50	0 0

16 ($ bil) if Airbus develops and produces the new airplane. Then, there exists a certain amount of US subsidy to Boeing that would deter Airbus from developing and producing the new airplane.

(C) Suppose that there only two firms capable of making TV sets in the entire world, and that the world consists of two countries, the US and Japan. Suppose that the US manufacturer is called ZENITH, and the Japanese firm is called SHARP. Each firm is considering developing the future High-Definition-TV (HDTV) having a resolution of 1275 lines (compared with the 575 lines of the current TV standard (called NTSC)).

Suppose further that each firm has a binary choice: develop (and produce) or Don't develop (and don't produce). The Table below demonstrates the profit levels of each firm under the four possible market outcomes.

SHARP		ZENITH			
		Produce		Don't Produce	
	Produce	2	3	50	0
	Don't Produce	0	50	0	0

What level of subsidy should MITI (Japan's Ministry of Intern'l Trade and Industry) provide SHARP in order to deter ZENITH from developing its HDTV (Can MITI succeed in deterring ZENITH?).

Set # 11: Effective Protection

(A) Suppose that each domestically produced computer uses *two* memory chips imported from abroad as the only input. The international price of this type of computer is $p_C = \$1000$ and the international price of *one* memory chip is $p_M = \$200$. If the government imposes a 20% tariff on computers (and no tariff on memory chips), then the *effective rate of protection* is 25%. True or false? Prove your answer!

(B) Suppose that each domestically produced computer uses *three* memory chips imported from abroad as the only inputs. The international price of this type of computer is $p_C = \$1000$ and the international price of *one* memory chip is $p_M = \$200$. If the government imposes a 20% ad-valorem tariff on imported computers and provides a 20% *subsidy* on imported memory chips then the *effective rate of protection* is 20% (zero). True or false? Prove your answer!

(C) Each American made car is produced with three imported components: 1000 lbs. of steel, 500 lbs. of plastic, and 10 lbs. of glass. Steel is imported from Korea at the price of $1 per lb., plastic is imported at a price of $2 per lb., and glass is imported from Italy at a price of $10 per lb.. Suppose that imported cars are perfect substitutes to American cars and that the free-trade price of each car is $10,000.

If the U.S. government imposes an ad-valorem tariff of 1% on cars and 100% tariff on glass, the government achieves an *effective* protection rate of 0% (zero percent). True or false? Prove your answer!

(D) Each notebook computer produced in the U.S. uses 1 LDC display produced by the SHARP^{TM} company located near Kobe, Japan. Each LCD display is imported at a price of $200. Assume that the free-trade price of a notebook is $2,000.

Suppose now that the U.S. government wishes to provide the domestic notebook-computer industry with an *effective* protection rate of 20%.

Let t_L denote the ad-valorem tariff rate on imported LDC displays and t_C denote the ad-valorem tariff rate on imported computers. Find all the combinations of t_L and t_C that together would generate a 20% effective rate of protection.

(E) Each computer uses 2 chips imported from abroad. The international price of a computer is $\$1000$. The international price of one chip is $\$200$. Under pressure from domestic manufacturers, the government imposes a 20% import tariff on computers only (there is no tariff on chips).

Compute the effective rate of protection on domestic computer manufacturers. *Hint*: First compute the relative value of chips as a fraction of the value of a computer.

(F) Palm-size computers (handhelds) produced in the U.S. are assembled from 2 chips and one hard drive (these components are imported and not produced domestically). The international price this type of computers is $\$1000$. The international price of one chip is $\$200$. The international price of a hard drive is $\$100$.

After intensive lobbying, the government imposes a 20% tariff on imported computers and a 40% tariff on hard drives. Note that no tariff is imposed on imported chips. Solve the following problems:

(i) Compute the effective rate of protected on domestically-produced palm-size computers. Make sure that you write down the appropriate general formula.

(ii) Compute the change in social welfare resulting from the imposition of these tariffs assuming that the domestic inverse demand curve for domestically produced computers is $p = 2400 - Q$.

(G) Each American made car is produced with three imported components: 1000 lbs. of steel, 1000 lbs. of plastic, and 100 lbs. of rubber. Steel is imported from Korea at the price of $2 per lb., plastic is imported at a price of $1 per lb., and rubber is imported from Italy at a price of $5 per lb.. Suppose that imported cars are perfect substitutes to American cars and that the free-trade price of each car is $20,000.

Compute the effective rate of protection on the U.S. car industry assuming that the U.S. government levies an ad-valorem tariff of $t_S = t_P = t_R = 40\%$ uniformly on all imported factors of production and a tariff of $t_C = 50\%$ on imported cars.

Set # 12: Strategic Trade Policy

(A) Consider the domestic market and suppose that the government provides a specific-production subsidy to the domestic firm. Thus, the profit of the domestic firm is now

$$\pi_1 = (a - q_1 - q_2)q_1 - cq_1 + sq_1,$$

and the profit of firm 2 is now

$$\pi_2 = (a - q_1 - q_2)q_2 - cq_2.$$

(i) Formulate the firms' maximization problem assuming that the subsidy level is given at the rate of s, and solve and plot the firms' best response functions.

(ii) Solve for the equilibrium output level of each firm, aggregate output, market price and the profit of each firm as a function of s.

(iii) Calculate the consumer surplus as a function of s. That is, calculate $CS(s)$.

(iv) Formulate the welfare function of country 1 as a function of s.

(v) Calculate the optimal subsidy level.

(vi) Which policy yields a higher domestic welfare: the optimal subsidy you just calculated, or the optimal tariff? You must prove your result!
Hint: You may want to follow the following steps:

i. Substitute the optimal subsidy you found into the economy's welfare function and calculate total welfare under the subsidy.

ii. Substitute the optimal tariff into the corresponding economy's welfare function and calculate total welfare under the tariff.

iii. Compare the two welfare levels.

(B) This question investigates whether the domestic country benefits or loses when a foreign firm is subsidized by the foreign government. Consider the domestic (home) country market only, where the aggregate demand for a homogeneous product is $p = 3 - Q$. There are two firms: firm 1 (domestic) and firm 2 (foreign). Assume that the two firms play Cournot, and the only the foreign government subsidizes the foreign firm by s per-unit of export to country 1 ($s < 3$). Assuming that production is costless ($c = 0$), the profit functions of the two firms from sales in country 1 are given by

$$\pi_1 = (3 - q_1 - q_2)q_1 \quad \text{and} \quad \pi_2 = (3 - q_1 - q_2)q_2 + sq_2.$$

Answer the following questions:

(i) Calculate the best-response function for each firm.

(ii) Calculate the equilibrium amount of sales by firm 1 and firm 2, and the market price. Conclude whether the foreign subsidy increases or decreases the sales of firms 1 and 2 and aggregate sales.

(iii) Calculate domestic consumer surplus, and the profit level of firm 1 and conclude whether the foreign subsidy increases or decreases (a) domestic consumer surplus, and (b) the profit of the domestic firm.

(iv) Formulate the welfare function of country 1 and conclude whether the foreign subsidy increases or decreases domestic welfare. *Note: Remember that the foreign subsidy is paid by country 2.*

(C) This question investigates the domestic country's optimal import quota policy under imperfect competition. Consider the domestic (home) country market only, where the aggregate demand for a homogeneous product is $p = 3 - Q$. There are two firms: firm 1 (domestic) and firm 2 (foreign).

The domestic government imposes an import quota on the import of firm 2. That is, the domestic government does not allow firm 2 to sell more that $\bar{q}$ units in the home country. Assuming that this quota is binding (that is, $q_2 = \bar{q}$, meaning that firm 2 does not sell less than $\bar{q}$), and assuming that production is costless, the profit function of the domestic firm, firm 1, is given by

$$\pi_1 = (3 - q_1 - \bar{q})q_1$$

Solve the following problems:

(i) Let firm 1 take the import level $\bar{q}$ as given (set by the domestic government). Calculate firm 1's profit maximizing output level as a function of $\bar{q}$. Does the output level of the domestic firm increase or decrease with $\bar{q}$? Show all your derivations.

(ii) Calculate firm 1's profit as a function of $\bar{q}$. Which level of quota maximizes firm 1's profit? Show your derivations.

(iii) Formulate the welfare function of the domestic country, assuming that social welfare is the sum of domestic consumer surplus plus the domestic firm's profit only.

Then, calculate the import quota level, $\bar{q}$ that maximizes social welfare. Show your derivations.

Hint: Make sure that you check the behavior of the function W as a function of $\bar{q}$ for the range $0 \leq \bar{q} \leq 3$.

(iv) Explain the effect of an import quota on the domestic firm's market power and consumer surplus. Explain how these effects determine the optimal quota level you calculated in (iii).

(D) Finland (F) imports oranges only from Spain (S) and the U.S. (U). Finland does not grow oranges. Finland's inverse demand function for oranges is given by $p = 120 - Q$. Assume oranges are costless to produce ($C = 0$). The U.S. government subsidizes the U.S. exported by $\$s$ for each unit exported. Therefore, the profit function of the U.S. exported is $\pi_U = (120 - q_U - q_S)q_U + sq_U$. The profit function of the Spanish exported is $\pi_S = (120 - q_U - q_S)q_S$.

(i) Solve for Finland's Cournot equilibrium level of imports from U and S, both as functions of s. Solve for the profit levels made by U and S exporters.

(ii) Assume that U's social welfare function is $W = \pi_U - sq_U$, which is the profit made by the U.S. exporter net of the export subsidy cost. Compute the per-unit subsidy s that maximizes social welfare.

(E) The inverse demand function for a certain good produced and imported to the U.S. is $p = 120 - Q$. The local producer can produce each unit at a unit cost $c = \$50$. The supply function of the same good supplied by China is perfectly elastic and is given by $p^c = \$40$. Assume that the domestic producer and the Chinese exported compete in prices (Bertrand) in the domestic market. Solve the following problems:

(i) Compute the profit of the local producer, domestic consumer surplus and social welfare.

(ii) Suppose now that after intensive lobbying the domestic producer managed to "convince" the government to subsidize domestic production at the rate of $s = \$20$ per unit produced. Compute again the profit of the local producer, domestic consumer surplus and social welfare.

(F) The inverse demand function for a certain good produced and imported to the U.S. is $p = 120 - Q$. The local producer can produce each unit at a unit cost $c = \$50$. The unit cost of the Chinese exporter is $c = \$40$. Assume that the domestic producer and the Chinese exported compete in quantity (Cournot) in the domestic market. Solve the following problems:

(i) Compute the total cost of the subsidy (to the U.S. taxpayer) assuming that the government subsidizes domestic production at the rate of $s = \$10$ per unit produced.

(ii) For every given subsidy level s (that is, not necessarily for $s = \$10$), compute the equilibrium price p, quantity sold (local production and imports), q^U and q^C the profit levels π^U and π^C. All should be expressed as functions of s.

(iii) Compute the total subsidy paid by the government, consumer surplus, and social welfare, all as functions of the per-unit subsidy s to the domestic producer.

(iv) Compute the subsidy rate s^* that maximizes social welfare of country U.

(G) The inverse demand function for a certain good produced and imported to the U.S. is $p = 120 - Q$. The local producer can produce each unit at a unit cost $c = \$50$. The unit cost of the Chinese exporter is $c = \$40$. Assume that the domestic producer and the Chinese exported compete in quantity (Cournot) in the domestic market.

Suppose the government imposes a specific tariff t on imports from China. Solve the following problems:

(i) For every given tariff level t compute the equilibrium price p, quantity sold (local production and imports), q^U and q^C the profit levels π^U and π^C. All should be expressed as functions of t.

(ii) Compute total tariff revenue T collected by the government, consumer surplus, and social welfare, all as functions of the specific import tariff t.

(iii) Compute the tariff rate t^* that maximizes social welfare of country U.

(H) Germany imports luxury Hammar vehicles from the U.S. The local Hammer distributer in Germany acts as a monopoly and bears a marginal cost of $c = 80$. The Germany inverse demand for Hammers is given by $p = 640 - Q$. Suppose that the German government imposes a tariff of t on this type of cars. Solve the following problems:

(i) Compute the quantity imported and the price as functions of t.

(ii) Compute the tariff rate which maximizes social welfare in Germany.

Set # 13: Int'l Factor Movement and Immigration

(A) Suppose that the labor requirement matrix in countries A and B is given by

	X	Y
A	3	4
B	5	2

where X and Y are the two goods that can be produced in each country with the help of a single factor of production called labor. Let the labor endowment in each country equal $L^A = L^B = 6$. Draw and explain the world production possibility frontier assuming that labor is *freely mobile* between the countries

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(B) Consider a world with two countries A and B and two goods X and Y. Each good is produced using labor only. Country A is endowed with $L^A = 24$ units of labor and country B with $L^B = 12$ units of labor. The following matrix provides the amount of labor needed to produced one unit of each good in each country:

	X	Y
A	2	3
B	3	2

Suppose that all consumers have the same preferences, and that they view both goods as perfect complements. Hence, they will always consume one unit of X for every one unit of Y.
Formally, $U(x, y) \equiv \min\{x, y\}$.

Assume that *labor is perfectly mobile between the countries* (and within countries). Solve the following problems:

(i) Draw the world production possibility frontier.

(ii) Calculate the aggregate world consumption of good X and good Y (under free trade in goods and labor).

(iii) Calculate the production level of X and Y in *each* country (under free trade in goods and labor).

(iv) Calculate how much labor will immigrate from one country (which one) to another?

(C) Consider a world with two countries A and B and two goods X and Y. Each good is produced using labor only. Country A is endowed with $L^A = 15$ units of labor and country B with $L^B = 15$ units of labor. The following matrix provides the amount of labor needed to produced one unit of each good in each country:

	X	Y
A	3	3
B	6	2

Suppose that all consumers have the same preferences, and that they view both goods as perfect complements. Hence, they will always consume one unit of X for every one unit of Y.
Formally, $U(x, y) \equiv \min\{x, y\}$.

Assume that *labor is perfectly mobile between the countries* (and within countries).

(i) Draw the world production possibility frontier.

(ii) Calculate the aggregate world consumption of good X and good Y (under free trade in goods and labor).

(iii) Calculate the production level of X and Y in *each* country (under free trade in goods and labor).

(iv) Calculate how much labor will immigrate from one country (which one) to another?

(v) Answer question (iv) assuming that consumers' utility function is now given by $U(x, y) \equiv y$ (that is, all consumers in the world wish to consume good Y only).

(D) Consider a world with two freely-trading countries A and B and two goods X and Y. Each good is produced using labor only. Country A is endowed with $L^A = 150$ units of labor and country B with $L^B = 150$ units of labor. The following matrix provides the amount of labor needed to produced one unit of each good in each country:

	X	Y
A	1	2
B	6	1

Suppose that all consumers have the same preferences, and that they view both goods as perfect complements. Hence, they will always consume one unit of X for every one unit of Y. Formally, $U(x, y) \stackrel{\text{def}}{=} \min\{x, y\}$.

Suppose that labor becomes international mobile (all immigration laws in the world are suddenly abolished). Then, despite the fact that labor migration is not restricted, no labor will immigrate from country A to country B and no labor will immigrate from country B to county A. True or false? Prove your answer!

(E) Consider a world with three freely-trading countries A, B, and B and two goods X and Y. Each good is produced using labor only. Countries A and B is endowed with $L^A = L^B = 1200$ units of labor and country C with $L^C = 1000$ units of labor. The following matrix provides the amount of labor needed to produced one unit of each good in each country:

	X	Y
A	4	1
B	3	4
C	1	2

Suppose that all consumers have the same preferences, and that they view both goods as perfect complements. Hence, they will always consume one unit of X for every one unit of Y. Formally, $U(x,y) \stackrel{\text{def}}{=} \min\{x,y\}$.

Assuming that labor is freely mobile among the three countries, compute the amount of labor that immigrates to/from each country. Prove your result!

(F) Solve the above problem assuming that consumers' utility function is given by $U(x,y) \equiv \min\{2x,y\}$, hence they consume according to the ratio $y^c = 2x^c$. Also assume that $L^A = L^B = L^C = 300$.

(G) Solve the above problem assuming $U(x,y) \stackrel{\text{def}}{=} x^2y$, $L^A = L^B = 1200$,$L^C = 2400$, and

	X	Y
A	4	3
B	3	4
C	4	4

(H) Solve the above problem assuming $U(x,y) \stackrel{\text{def}}{=} x^2y$, $L^A = L^B = 900$, and

	X	Y
A	3	4
B	4	3

(I) Consider a world with three freely-trading countries A, B, and C and two goods X and Y. Each good is produced using labor only. Countries A, B, and C are endowed with $L^A = 100$, $L^B = 200$, and $L^C = 300$ units of labor, respectively. The following matrix provides the amount of labor needed to produced one unit of each good in each country:

	X	Y
A	5	1
B	4	4
C	2	5

Suppose that all consumers have the same preferences, and that they view both goods as perfect complements. Hence, they will always consume one unit of X for every one unit of Y. Formally let $U(x,y) \stackrel{\text{def}}{=} \min\{x,y\}$.

Assuming that labor is freely mobile among the three countries, compute the amount of labor that immigrates to/from each country. Prove your result!

Set # 14: Free Trade Agreements (FTA)

(A) Consider a world with three countries named: M (for middle), E (for east) and W (for west). Country M can import tennis shoes from E or W. Suppose that M does not have a tennis shoes industry. The inverse demand function for shoes in country M is $p = 120 - Q$.

The price of a pair of shoes in country E is \$30, while the price of a pair in country W is \$59.99.

Country M considers two options.

- To sign a free trade agreement (FTA) with country W, and levy 100% tariff on shoes imported from E.
- Not to sign an FTA with W and to levy 100% tariff on shoes imported from any foreign country.

Compute which option yields a higher social welfare level to country M.

(B) Consider the free trade agreement model analyzed in the lecture notes. Suppose that the world consists of three countries denoted by A, B, and C. Country A imports shoes from countries B and C and does not have local production of shoes. The inverse demand function in country A is $p = 120 - Q$. Let the export shoe prices of countries B and C be given by $p_B = \$60$ and $p_C = \$40$. Also, suppose that initially, country A levies a uniform import tariff of $t = \$10$ per each pair of imported shoes. Answer the following questions:

(i) Suppose that country A signs a FTA with country B. Does country A gain or lose from this agreement? Explain!

(ii) Suppose now that initially, the export price of shoes in country C is $p_C = \$50.01$. Under this condition, will country A gain or lose from the FTA? Explain!

(C) Explain the *Most-Favored Nation* (MFN) principle. Also, explain under what conditions GATT members are not obligated to obey the MFN.

(D) Turkey imports cars from Japan and the EC. Turkey does not produce cars. Japanese car producers export each car at a price of \$15, whereas European car producers export each car at a price of \$16. At this moment, the EC refuses Turkey's request to be admitted to the EC on the basis of a slow progress in human rights (which many believe to be just an excuse to avoid having Turkey supplying cheap labor to the EC). Therefore, *all* cars imported into Turkey are subjected to a *specific tariff* of \$10 per car.

The demand for cars in Turkey is given by $Q = 240 - p^T$, where p^T denotes the tariff-inclusive price of a car sold in Turkey.

(i) Calculate Turkey's total social welfare under this uniform tariff on cars. Show your work, and make sure that you properly define the social welfare function.

(ii) Many economists believe that Turkey will eventually join the EC by the year 2000. Calculate Turkey's social welfare after it joins the EC.

(iii) Will Turkey become better off when it joins the EC? Prove! Explain using Viner's terminology.

(E) Consider a world with 3 countries: U.S. (U), Asia (A) and Europe (E). Assume that only shoes are traded. Country U does not produce shoes, but it can import shoes from countries A or E. The price of shoes is $p_A = \$20$ in country A, and $p_E = \$30$ in country E. The inverse demand curve for shoes in U is $p = 120 - Q$. Solve the following problems:

(i) Suppose country U imposes 100% tariff on imported shoes (from any country). Using the appropriate graph, calculate the amount of imported shoes, U's consumer surplus, government's revenue, and its social welfare.

(ii) Answer the above question assuming that country U has signed a free-trade agreement with E, but continues to levy 100% tariff on imports from A. Conclude whether country U's benefits or loses from this FTA.

(F) Solve the above problem assuming 200% tariff rate (instead of 100%).

(G) Consider a world with 3 countries: U.S. (U), Asia (A) and Europe (E). Country U does not produce shoes (S) and pasta (P). Therefore U imports both goods. A pair of shows costs $p_S^A = \$20$ in A, and $p_S^E = \$30$ in E. The U.S. inverse demand for shoes is $p = 120 - Q$.

Pasta is produced in E only (Italian style), and costs $p_P^E = \$30$ (per kilogram) in E. The U.S. inverse demand for pasta is $p = 240 - 2Q$. Solve the following problems:

(i) Suppose country U levies a uniform tariff of %100 on all imported goods from any origin. Compute the import level of each good, domestic consumer surplus and social welfare.

(ii) Suppose now that the government of country U signed a free-trade agreement with country E, however, it still levies 100% tariff on imports from A. Compute the import level of each good, domestic consumer surplus and social welfare, and conclude whether this FTA is welfare improving or reducing for country U.

(H) A country imports two goods: Good 1 and good 2. There is no local production of these goods. The domestic inverse demand function for good 1 is $p_1 = 90 - Q_1$. The inverse demand function for good 2 is $p_2 = 240 - Q_2$.

The country can import the two goods only from 2 sources: Europe (E) and Asia (A). The domestic prices when the country levies a 50% tariffs on all imports (and when it does not levy any tariff) is given in the following table.

	p_1	$p_1(1+t)$	p_2	$p_2(1+t)$
Country E	20	30	100	150
Country A	40	60	80	120

Solve the following problems:

(i) Compute the country's level of social welfare under the above uniform import tariff.

(ii) Compute social welfare assuming that the country signs free trade agreements with both country E and country A.

(iii) Compute social welfare assuming that the country signs a FTA with country E only, and continues to levy a 50% tariff on all imports from A.

(iv) Compute social welfare assuming that the country signs a FTA with country A only, and continues to levy a 50% tariff on all imports from E.

Set # 15: Misc. Topics

(A) What are the two legal definitions of *dumping*? Also, explain why firm may engage in a dumping activity?

(B) In the a country called *Protectia*, $1/3$ of the voters are Land owners, $1/3$ are workers (Labor in what follows), and $1/3$ are Capital owners. The following matrix shows the gains and loss to *each* type of voter from two policy proposals.

	Land	Labor	Capital
Tariff on cars	-1	-2	$+10$
Subsidy to corn growers	$+10$	-1	-1

Assuming that side payments are illegal, if policies are determined by the median voter mechanism, then either a tariff on cars will be imposed, or a subsidy will given to corn growers, but not both. Prove your result!

The End

