Section 1

- Parameter - variable we hold constant (i.e., income)
  - when a variable changes it moves along the graph
  - when the value of a parameter changes, the line shifts

- Demand - the consumers willingness to pay a price for a specific good
  - items that can make the demand curve change (price, income, compliments)
  - when the slope is constantly changing use the derivative to find (1 variable)
    \[ \frac{dy}{dx} = 4 \cdot \frac{1}{2} \cdot x^{\frac{1}{2} - 1} = 2x^{-\frac{1}{2}} \]
- Partial Derivative - still has a dependent but has two independent variables
    \[ \frac{dx}{du} = 4 \cdot \frac{1}{2} \cdot x^{\frac{1}{2} - 1} \cdot y^{\frac{1}{3}} = 2x^{-\frac{1}{2}} y^{\frac{1}{3}} \]

Section 2

- Fundamental Model of Microeconomics - will be applied everywhere "climb hills"
  - topographic map - lines cannot touch, indefinite density, more or less the top of a topo map (different altitudes)
  - \( U = \text{utility(hill)} \), \( U = f(X,Y) \)
  - \( \text{MU}_x \) - how one variable changes (dependent) b/c of a very small change in the other

- diminishing marginal utility - as you consume more of a good the extra utility you get starts to go down
  - iso-utility graph
Section 2

- All of economics is constrained optimization
- Preferences are given by the utility function \( U = f(x, y) \)
- At optimum, the BC is equal to the IC
  - Slope of BC: \( M_{BC} = -\frac{P_x}{P_y} \)
  - Slope of IC: \( M_{IC} = -\frac{MU_x}{MU_y} \)
- At optimum: \( M_{BC} = M_{IC} \rightarrow \frac{P_x}{P_y} = \frac{MU_x}{MU_y} \) (optimal condition)

Section 3

- Always calculate \( MU_x + MU_y \) first
- Opportunity set use an equal (=)
- Feasible set uses (≤)

\( BC: P_x x + P_y y = I \)

\[ \text{Opt}(x^*, y^*) \Rightarrow M_{BC} = M_{IC} \]

\[ m = \frac{MU_x}{MU_y} \]

- Indifference Curve - every point at which the utility is the same (iso-utility)
  - Equal slopes condition
  \[ \frac{MU_x}{P_x} = \frac{MU_y}{P_y} \]
  - Marginal utility per dollar of every good in the consumption bundle must be the same

- If you have multiple constraints, can you satisfy all the constraints at the same time? Answer: No you cannot simultaneously satisfy all of them.
Section 3

- When the price of a good changes, the consumption of a good changes as well.

- Why do we buy less of a good when the price goes up? Answer: we feel poorer and other things become cheaper (happen in conjunction)

Total Effect = Substitution Effect + Income Effect (TE = SE + IE)

\[
\begin{align*}
X_t & \quad \text{Substitution Effect - is always negative and we are keeping the income effect constant by holding the original utility the same} \\
X_0 & \quad \text{Total Effect} \\
X_s & \quad \text{Broken down Total Effect}
\end{align*}
\]

Income Effect - the change in consumption resulting in a change of real income.

- Normal Good - price increases, a substitute option is cheaper
- Inferior Good - sometimes as price increases we feel richer
- Giffen Good - SE is still always negative, but the income effect is so negative it becomes positive, making TE positive

- For most goods the income effect is negative (because we feel poorer)

- Derived Curves -
**Section 3**

- When income changes, the constraints shift outward, nothing else changes.
- Income Expansion Path - shows how different income affects consumption of two different products.

- Engel Curve helps us to capture if the good is inferior or not.

- There is no difference in Graph 1 & Graph 2.
- Start with the demand curve with all constraints: \( P_x X + P_y Y = I \).
- Locate the variables of interest (i.e., demand curve) \( P_x X + P_y - Price, X = \text{Quantity} \).
- \( P_x X + P_y Y = I \); for an Engel curve, we are looking at variables \( (X + I) \).
- Every good has to be normal for some part of the curve.
- Not every good in your consumption bundle can be inferior.

\[
\frac{3x}{2} = \frac{6}{7} \Rightarrow 4x = 7x 
\]

- Use equal slope condition & solve for the optimum ratio.

\[
6x + 7 \left( \frac{2}{3} X \right) = I 
\]

- Use budget constraint & solve for \( X \) (plug in \( X \) value).

\[
10X = I 
\]

- Engel Curve.

\[
MRS_{px} = \frac{P_x}{P_y} 
\]

- Use equal slopes condition & plug in \( P_x \) instead of the given original price (solve for \( y = \frac{2}{3} P_x X \)).

\[
P_x X + 7 \left( \frac{2}{3} P_x X \right) = 250 
\]

- Use original budget constraint & plug in \( P_x X \) +

Solve to get \( P_x X = 150 \).
Section 3

- Budget Share of Elasticity - measures the

\[ 10X = I \rightarrow \frac{X}{I} = \frac{1}{10} \]

*use the Engel curve for X and solve for \( \frac{X}{I} \)

\[ BS_x = \frac{p_x X}{I} \]

*use budget formula and set equal to original price

\[ G = \frac{1}{10} \rightarrow \frac{3}{5} \]  ← Budget Share of X

\[ \varepsilon_{I/X} = \frac{dX}{dI} \times \frac{1}{X} \]

*income elasticity of DD for X

\[ 1 = \frac{1}{10} \times 10 \]
Income Substitution (Example)

\( p_x = $16 \rightarrow $9 \)

\((X_0, Y_0) = (25, 14.29) \) ← original / initial consumption

\((X_f, Y_f) = (16.67, 14.29) \) ← final / new consumption

\( X^*: X_0 \rightarrow X_f \)  * use original + final consumption bundles to find

\( Y^*: Y_0 \rightarrow Y_f \)  * TE. (Falls, rises, no change)

\[ U_0 = 4 \left( X_0^* \right)^{\frac{1}{2}} \left( Y_0^* \right)^{\frac{3}{2}} \]  * Plug in original consumption to the original utility function

\[ U_0 = 48.53 \] ← Initial Utility Level

\[ U_5 = 4 \left( X_5^* \right)^{\frac{1}{2}} \left( Y_5^* \right)^{\frac{3}{2}} \]  * Substitution Utility Level is the same thing (no calculation)

\[ U_5 = 48.53 \] ← Substitution utility level

\[ \frac{\partial U}{\partial X} = \frac{9}{7} \rightarrow 6X = 7Y \]  * Use the final optimal condition, from price change ($p_x$ to $p_f$)

\[ 4 \left( X_5^* \right)^{\frac{1}{2}} \left( Y_5^* \right)^{\frac{3}{2}} = 48.53 \]  * Plug into original utility function & set equal to \( U_5 \)

\((21.26, 18.33)\)  * Solve For \( (X_5^*, Y_5^*) \) ← Substitution point

\( X^*: X_0 \rightarrow X_5 \)  * use original bundle + substitution points to find

\( Y^*: Y_0 \rightarrow Y_5 \)  * SE. (Falls, rises, no change)

\( X^*: X_5 \rightarrow X_f \)  * use substitution bundle & final bundle to get the

\( Y^*: Y_5 \rightarrow Y_f \)  * IE. (Falls, rises, no change)

Equivalent Variation - the measure of economic welfare associated with a change in price.
Income + Substitution (Example Continued) → Equivalent Variation

\((X^*_T, Y^*_T)\)  • Use the final consumption bundle

\[U_T = 4(X^*_T)^{\frac{1}{2}} (Y^*_T)^{\frac{1}{3}}\]  • Plug final bundle into original utility function

\[= 39.69 \quad \rightarrow \text{Final Utility Level}\]

\[U_R = 4(X^*_R)^{\frac{1}{2}} (Y^*_R)^{\frac{1}{3}} \quad \text{Equivalent variation level is the same thing (no calculation)}\]

\[U_R = 39.69 \quad \rightarrow \text{Equivalent variation level}\]

\(\frac{\partial Y}{\partial X} = \frac{6}{7} \Rightarrow 4X = 7Y\)  • Use the original optimum condition, before price change (A.19c)

\[4(X^*_R)^{\frac{1}{2}} (Y^*_R)^{\frac{1}{3}} = 39.69\]  • Plug into original utility function and set equal to \(U_R\)

\((19.61, 11.20)\)  • Solve for \((X^*_R, Y^*_R)\) → Equivalent Variation Point

\[6X + 7Y = 250\]  • Use the original budget constraint and plug in \((X^*_R, Y^*_R)\)

\[= 311.96.06\]  • to solve for the final budget

\[250 - 196.06 = 53.94\]  • Take the original budget constraint and subtract final budget to get the "pay to avoid increase"
Section 4

Similarity between TOC and TOF

Utility Function: \( U = f(x, y) \) ← consumer preferences
Production Function: \( Q = f(L, K) \) ← technology

At optimum (TOC)
\( M_{BC} = M_{EC} \rightarrow \frac{p_x}{p_y} = \frac{m_{ux}}{m_{uy}} \)

At optimum (TOF)
\( M_{IT} = M_{IQ} \rightarrow \frac{w}{r} = \frac{mp_L}{mp_K} \)

View of Vertical Slice

\( U = f(x, \bar{y}) \) ← hold \( y \) constant

\( Q = f(L, \bar{K}) \) ← hold \( K \) constant

We care more about the horizontal slice of the topo map

\( BC: p_x x + p_y y = I \)

\( IT: wL + rK = C \)

Linear constraint
\( y = mx + c + Ax + By = c \)

\( BC: p_x x + p_y y = I \)
\( M_{BC} = -\frac{p_x}{p_y} \)
\( M_{EC} = -\frac{m_{ux}}{m_{uy}} \)

\( IT: wL + rK = C \)
\( M_{IT} = \frac{w}{r} \)
\( M_{IQ} = -\frac{mp_K}{mp_L} \)
Section 4

- There is one economic difference in TOC + TOE, theory of the firm has an equation of three unknowns vs. theory of the consumer only has two.

\[ \text{TOC} \]
- BC: \( P_x X + P_y Y = I \)
- 3 Parameters - \( P_x, P_y, I \)
- 2 Variables - \( X, Y \)
- Exogenous (given to vs)
- Equation of two unknowns
- \( X + Y \) can be defined completely by the model

\[ \text{TOE} \]
- IT: \( w L + r K = C \)
- 2 Parameters - \( w, r \)
- 2 Variables - \( L, K \)
- Endogenous to the model (need to find \( C \))
- \( K + L \) cannot be determined completely by model

- Think of two offices you are in the middle managing with a goal to maximize profit
- The back office + the front office are completely independent

\[ \begin{align*}
\text{Back} & \quad \text{Front} \\
\text{Technology} & \quad \text{Preferences} \\
\downarrow & \quad \downarrow \\
Q = f(L, K) & \quad Q = f(p) \quad Q \rightarrow \text{Demand Curve} \\
\downarrow & \quad \downarrow \\
C = f(Q) & \quad R = f(Q) \quad \text{Revenue is a function of} Q \\
\downarrow & \quad \downarrow \\
MC \rightarrow \boxed{\text{Max}} & \quad MR \\
\end{align*} \]

At profit maximizing \( MR = MC \). We set equal to 0 with the first order condition and solve.
Section 5

- You should be paid how much you are worth to the company that you are producing at the marginal rate.

\[ MC = MR. \]

\[ MFC = MFR. \]

- First optimization principal in terms of output

\[ MFP_L \text{ / } VMP_L. \]

- Optimization principal in terms of input

\[ MP_L \text{ / } MFR. \]

- MFC, firm is paying for your labor \((w)\)

\[ W = MP_L \times MR. \]

- What you produce \((MP_L)\), & what you are selling the last unit of production for \((MR)\)

- No demand for labor above \(\hat{w}\) (wages are too high)

\[ W = \begin{cases} \text{MRP}_L \text{ if } \text{MRP}_L \leq \text{ARP}_L, & w \leq \hat{w} \\ 0 \text{ if } >, & w > \hat{w} \end{cases} \]

- \(\text{MRP}_L\) has to be lower than \(\text{ARP}_L\) because you can not have negative labor.

- Price is a Fixed Marginal Revenue

- Short-run demand curve for labor, all above
Section 5 (Market Structure)

- The single thing that makes a firm perfectly competitive: no barriers to entry + free exit (only reason profits are $0)

\[ px = \text{Profit} = \text{MC} \]

- When \( MC = AC \), profit is $0
- \( P \) is fixed MR because the point of average cost is at a minimum
- AC curve is fixed; if the price is fixed, bottom of the cost curve is fixed
- We are to find \( P^*, q^*, Q^*, n, \tilde{n} \)

1. \( AC = MC \)
2. \( AC_{min} \)
3. \( TR = TC, \tilde{n} = 0 \)

Long-run: Find \( P^*, Q^*, q^*, n^*, \tilde{n}^* \)

Short-run: \( n^* \) does not change, MC function does not change

Long-run: \( MC + AC \) do not change, \( q^*, P^*, \tilde{n}^* \) are the same; \( n^* + Q^* \) change.
Section 6 (Midterm Review)

- Review the ETC Section

PS1: #2

- It does not matter which way the curve swings, as soon as you have a higher line you are on a higher indifference curve (higher utility)

- We are only concerned with the highest constraint which will be the furthest away from the origin

PS1: #3 - Why is bread not a Giffen Good?

- We are looking at the reaction when purchasing that good when the price of the good changes. (1 good, 1 constraint, 1 price)

PS1: #4 - Price expansion path

- We are looking if the goods are in lock step (both goods working together; normal or inferior) *No good can be inferior over the entire price range

PS2: #1

- If you have a marginal cost curve & the MC is constant, if there are fixed costs the average cost falls

PS2: #2 - In the short-run, K is fixed

PS2: #3 - Remember the caviot, you will not hire labor above a certain price

- Work Leisure - find the equation for the constraint if you are given the utility function
Section 6 (Mid-term Review)

- Profit maximizing is better than Revenue Maximizing, because in real life you want to make profits.

- PSA2: #6 - Perfect Competition
- If the production function does not change, the cost does not change.
- The Front office (demand) starts with consumer preferences.
- So in the short-run, cost does not change (PSA2: #6 B) and the number of firms does not change.

- TFP does not assume Perfect Competition.

Graduate Review

- Answer the Lagrange in the correct format -> GPS #1
- Standard Cobb Douglas Function -> GPS #2 (be able to follow the steps)
- Elasticity is very important & you have to nail it (Part C)

* if $Q = AK^aL^b$
then $C = wL^k + rK^l$
$C = Bw^*r^kQ^l$

*must know boxed section in static after question #1.

- PS1, PSA, Section Questions.
Section 7

* AC min is also the minimum efficient scale (MES)
* MES is when we are looking at this graph as a plant
* MES is the most efficient point even if you can produce at different levels
* Example of a demand short; no more firms can enter the industry
* End up in the short-run \( \rightarrow \) firms flood in due to PC (free entry and exit) because you can make a profit \( \rightarrow \) brings back down \( Y = D_0 \). A \( \rightarrow \) B \( \rightarrow \) C
* Supply long run in PC is always a straight line

* Monopolies can be categorized in two different ways:
  1. How they are formed (i.e. what causes them to become a monopoly)
    1. Structural (i.e. natural) - monopoly destined to happen
      * sometimes it makes more sense for one firm to produce it than many
    2. Strategic - a company strategize to corner the market
      * ex: De Beers
  3. Legal (i.e. license) - government gives one firm the right to produce
    * offer of a specific product or service at regulated prices
      * example of another natural monopoly
      * if another firm comes in same business model, split production \( \rightarrow \) price goes up

Iconic natural monoply case

* as you produce more, price Falls
What do cost curves mean? Who’s cost curve is this?

Cost curves are coming from technology, technology is given
to us by the production function.

Cost curve for a factory/plant.

Cost curves for the firm: we assume the firm has 1 plant
but there can be multi-plant firms.

Cost curve for an industry: can have 1 or more firms.

Monopolies can be categorized in two different ways:

2. Price Discrimination - power to discriminate, 3 different ways.
   
   In PC, the firm cannot control price + price taker (must accept price).

   IF you are not in PC, your firm can affect price + price maker/setter.

   1. First-degree or perfect price discrimination
   
   Discriminate + set a different price for every individual product or service I sell.

   2. Second-degree price discrimination
   
   Bulk discounts.

3. Third-degree price discrimination
   
   Multi-plant monopoly, multi-market monopoly

- Arbitrage - buying a security in one market & selling in another for higher

  ex: medication purchases in Canada are cheaper than in US

  because arbitrage is not possible

- Segregation - this can stop arbitrage (due to the internet this became easier)
Section 8

* Review of PS3: #2 + #3

* Key is to find point of intersection

Here, we are looking at situations where there can be different markets one is selling in.

3rd Degree - discriminating on the basis of multiple markets & these markets arise because of segregation & we have arbitrage.

If MR is linear, the demand curve has the same intercept & is \( \frac{1}{2} \) the slope of MR vice versa. MR is twice the demand curve slope.

We decide what markets to sell in based off total profits (II).

If we are going to sell \( q_1 \) or anything between \( 0 + q_1 \), which market do you sell in? Answer: Sell in market A, because the MR is higher.

If we are selling anything beyond \( q_1 \), we sell in both markets.

Answer: b/c you get some revenue from A + some from B.

* Important concept

There is no limit to the number of markets you can sell in, but depending on where the MC crosses the kink, determines which market to sell in.

MC curves - producing something in two different plants.

If you are producing \( q_2 \) or anything between \( 0 + q_2 \), which market do you produce in? Answer: 1, because it is cheaper to produce.
Section 8

- Quantity is a function of Price or you can rewrite as Price is a function of Quantity

\[ P_A(q_A) \rightarrow MR_A(q_A) \]

- Price as a function of quantity & you can directly calculate MR as a function of quantity (multiply \( q \) by 2)

\[ q_A(MR_A) + q_B(MR_B) \]

- We are solving for the quantity & then combining them (MR's are now the same quantity)

\[ Q = q_A + q_B \]

- Now we have \( MR = MR_A = MR_B \) & can solve

1st degree price discrimination

- In a typical situation Demand = Avg. Revenue Curve, MR falls at twice the speed of the Avg. Revenue Curve

- Demand curve is a schedule of different price & quantity combos

- Demand is a schedule of reservation prices

- There is always someone who is willing to buy at a higher or lower price, you can charge everyone at the price they are willing to buy (1st Degree)

- MR swings up - now we have the demand curve (Avg. Rev Curve) & MR are identical

- This causes the firm to be able to make as much profit they can from an individual

- Pareto Efficiency → see next page
Section 8

- Economic (or Pareto) Efficiency is achieved when the allocation of inputs (factors) + output (goods) is such that there is no other feasible allocation that would make some agent better off without making another worse off. The conditions for Pareto Efficiency are:

- \( MRS_x = MRS_y \Rightarrow \) Exchange Efficiency: Same MRS for any two goods \( X+Y \) for all consumers.
- \( MRT_{a} = MRT_{b} \Rightarrow \) Input Efficiency: Same MRT for any two inputs \( A+B \) for all producers.
- \( MRS_{yx} = MRT_{yx} \Rightarrow \) Output Efficiency: Same MRS for the same two goods \( X+Y \).

If all three situations are met we have Pareto Efficiency.

Marginal Rate of Transformation (MRT) - Slope of the Production Possibilities Frontier and is the ratio of the MC of the goods \( X+Y \): \( MRT_{yx} = \frac{MC_x}{MC_y} \).

- \( G = Guns \), \( B = Butter \)

- This is P.P.F graph which is important because it looks at the rate an economy can move productive ability (i.e. producing guns to producing butter).
Section 9

- Duopoly is fundamentally different than the other market structures because it deals with strategy and reaction.
- In PC, we do not care about the other firms because they are doing the same thing.
- In monopoly, we do not care about other firms because there is only one.
- In duopoly, the name of the game is what the other firm is doing.
- There are 3 kinds of Duopoly: memorize!
  1. Bertrand — compete on price
  2. Cournot — compete on quantity; simultaneous entry (same time)
  3. Stackelberg — compete on quantity; sequential entry (leader/follower)

- If two firms are competing, they can compete on the basis of price/quality.

Nash Equilibrium Matrix: PS3, page 7

- Payoffs & Strategies: it is my payoff
- Payoffs are what we get by following a strategy.
- Strategy is more important than payoffs.
- Ex: Job 1 & Job 2 (Strategy): compare the sets of payoff and choose a strategy.
- Always think in terms of payoffs, but always answer in terms of strategy.

\[
\begin{array}{c|cccc}
& 0 & 1 & 2 & 3 \\
\hline
0 & 0,0 & 0,12 & 0,20 & 0,34 \\
1 & 13,0 & 11,10 & 9,16 & 7,18 \\
2 & 22,0 & 18,8 & 14,8 & 10,12 \\
3 & 0,0 & 0,86 & 0,54 & 9,6 \\
\end{array}
\]

- Inside the matrix are pairs of payoffs.
- \(q_1, q_2\) are the strategies.
- We are looking for best response.
- Nash equilb - both firms payoff are in the same cell.
- Dominant - all circles or diamonds are in the same row or column.
- Dominated - strategy you never take.
Section 10

Game Theory - mathematical study of strategy
Strategic Situation - minimum of two players, do not have to be sapient but cannot be nature
Prisoners Dilemma - 2 x 2 game → each player has 2 strategies + 2 options

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>R, R</td>
<td>S, T</td>
</tr>
<tr>
<td>D</td>
<td>T, S</td>
<td>P, P</td>
</tr>
</tbody>
</table>

- C = Cooperate, D = Deflect
- Social dilemmas games payoffs
  - R = Reward, P = Punishment, T = Temptation, S = Suck
  - P does not need to be equal; j just stands for the payoffs

- There are 4 social symmetric dilemmas games & that depends on how we rank the payoffs
  - \( T > R > P > S \) → Prisoners Dilemma
  - Nash Equilibrium of Prisoners Dilemma is \( D, D \) → NE = \((D, D)\)
  - Two reasons prisoners dilemma is a dilemma:
    1. RA is better than PP; CC dominates DD but given any change individually you would choose defection so as a group you choose mutual defection
    2. Rule: If a game has 0 or 2 Pure - Nash Equilibrium, there is always 1 mixed Nash Equilibrium

Bartrand Duopoly

\[ p_1 > p_2 > S \]

- \( T = \) Temptation = \( \pi \) monopoly
- \( R = \pi / 2, P = 0, S = \emptyset \)
- Any \((C, C)\) you are colluding having mutual cooperation + the idea is to set \( \pi \) max + split profits evenly
  - From \((C, C)\) to \((D, D)\) this is immediate (cooperation is dished)
  - Ex: A charges $100, B decides to charge $99 (Temptation), A comes back to charge $98, etc.

* Reaction Function on the basis of price, two firms reacting to price □
Section 10

* Insurance - we purchase because we want to be risk averse
* Risk aversion - reduce the volatility - we do not like the there is a possibility we will lose all of it, not just some of it
* Willing to give up something today so we feel more secure

\[ \begin{align*}
Y_g & \quad Y_g^* \\
Y_g & \quad Y_g^* \\
IC & \quad BC \\
Y_b & \quad Y_b
\end{align*} \]

* to solve we first need the equal slopes condition (slope of BC + IC)
  * equation of the constant
  * we are always comparing \( \hat{\Pi} \) (profit probability) + \( \gamma \) (gamma - premium per dollar) of insurance
  * if these are equal we call them actual fair situation

\( \hat{\Pi} \) - chance of loss
\( \gamma \) - premium per dollar of insurance

\( \hat{\Pi} > \gamma \) - chances of a loss > insurance (over insure, lose is better off)
\( \gamma > \hat{\Pi} \) - insurane > chance of loss (pay more for the chance of loss under more)
\( \gamma = \hat{\Pi} \) - actual fair situation

slope \[ m_{BC} = - \frac{\gamma}{1 - \gamma} \]

\[ U = \ln (Y) \] - equation how insurance is given
  * only 2 unknowns
  * Utility if a Function of all Income (Y)

\[ m_{IC} = \hat{\Pi} \frac{MU_Y Y_b}{(1 - \hat{\Pi}) MU_g \left(1 - \hat{\Pi}\right) MU_g} \]

\[ Y = m_X + c \]
\[ Y_g = m_{BC} Y_b \] (constant)
\( Y_g^* \) = initial endowment

(\( Y_g^*, Y_g^* \)) - ANSWER Format