



Paper 1: Fundamentals of Economics and Management (FEM)

PRICE AND OUTPUT DECISIONS UNDER OLIGOPOLY

Meaning of Oligopoly

Oligopoly is defined as a market structure in which there are a few interdependent sellers and each controls a significant part of supply and can influence the market price of the product. According to **Prof. Leftwich**, 'Oligopoly is a market situation in which there is a small number of sellers and the activities of every seller are important for others.' **George J. Stigler** defines oligopoly as 'that situation in which a firm bases its market policy in part on the expected behaviour of a few close rivals.'

Under oligopoly the products of different sellers may be homogenous or differentiated. Where products of rival firms are homogenous, it is called pure or homogenous oligopoly and where products are differentiated, and then it is called differentiated or heterogeneous oligopoly. Under pure oligopoly the degree of interdependence between price-output policies of the oligopolistic firms is higher than under differentiated oligopoly. Cement, steel, petrol, cooking gas, chemical, aluminium and sugar industries are examples of pure oligopoly whereas automobiles, television sets, soaps and detergents, J refrigerators, soft drinks, computers, cigarettes, etc., are some examples of industries characterised by differentiated oligopoly.



Characteristics of Oligopoly

- (i) **Few Sellers:** Under oligopoly, the number of sellers is few. It is more than two part but not so large as to create perfect competition. That is why; increase or decrease in output of one seller materially affects the market price.
- (ii) **Homogeneous or Differentiated Products:** The products of different sellers may be homogeneous or differentiated.
- (iii) **Interdependence:** Due to number of sellers being less and their products being homogeneous or similar, they are close substitutes; hence there is strong interdependence between their price-output policies. Degree of their interdependence is different according to the nature of oligopoly. In case of pure oligopoly interdependence is high but in case of differentiated oligopoly it is less. Cross elasticity of demand of the products of different sellers is high. Hence, they thoroughly consider the price and output policy of each other.
- (iv) **Indeterminateness of Demand Curve:** Under oligopoly, the form of demand curve of a firm is not clear because it cannot forecast reactions of its rivals to its price-output policy. Under it demand curve of a



firm is generally sloping from left to right.

- (v) **Price Rigidity:** Due to uncertainty of reactions of rival firms to price change, a single firm does not dare to change the price of its product because it believes that on a increase in price, rivals will not follow and it will lose its market and on reduction in price, there will be price war. That is why, under oligopoly no firm initiates price change and price rigidity is found.
- (vi) **Non-price Competition:** Under oligopoly, every firm avoids price competition. But to enlarge their market share, firms try to attract the customers by granting credit facilities, free gift, long warrantee of after-sales service, etc.
- (vii) **Advertisement and Sales Promotion Activities:** Under oligopoly, firms resort to aggressive advertisement and other sales promotion activities to sweep the market. Expenditure on advertisement and other sales promotion activities is higher in case of differentiated products as compared to homogeneous products.
- (viii) **Barriers to Entry:** Oligopoly is characterised by the presence of strong barriers to entry. These barriers may be due to economies of scale available to existing firms, technology and heavy initial investment requirements, ownership of strategic resources with no close substitute, patents, tariff, quota, licensing, etc.

Emergence of Oligopoly

Following are the reasons of emergence of oligopoly:

- (i) **Huge Capital Investment:** Industries like cement, steel, chemicals, petroleum, aircrafts, ship-building, etc., are highly capital intensive and require huge capital investment. Therefore, only a few firms can enter into these fields.
- (ii) **Absolute Cost Advantage :** Due to large scale production, the large units enjoy absolute cost advantage due to economies of scale in purchase of industrial inputs, marketing, financing and sales organisation. This works as a deterrent for the entry of new firms.
- (iii) **Patent Rights:** In case of differentiated oligopoly, firms get their products patented which gives them an exclusive right to produce and market the patented commodity. This keeps the number of firms limited.
- (iv) **Control over Natural Resources:** Where a few firms acquire control over the entire supply of important inputs required to produce a certain commodity, new firms find it extremely difficult to enter the industry.
- (v) **Merger and Takeover:** Now-a-days merger of rival firms or takeover of rival firms by a the bigger ones with a view to protect their joint market share and eliminate. Competition, has emerged as an important factor is strengthening the oligopolistic tendency in modern industries.
- (vi) **Informal Collusion:** Sometimes, firms engage in informal agreements among themselves to restrict output and charge higher prices to enhance their position against potential entry of new firms. These agreements are implicit in nature and are less likely to be noticed by law enforcing authorities.

Difference between Monopoly and Oligopoly

- (i) **Number of Sellers:** Under monopoly there is only one seller whereas under oligopoly, the number is more than two and not so large as to create perfect or monopolistic competition.
- (ii) **Substitutes:** Under monopoly there are no substitutes available in the market but under oligopoly close substitutes are available in the market.
- (iii) **Product:** Under monopoly there is only one product but under oligopoly homogenous or differentiated products of other manufactures are available in the market.
- (iv) **Agreement:** Under monopoly there is no question of any agreement between the sellers, since there is only one seller but under oligopoly, oligopolistic firms usually make manual agreement regarding price and output of the market.
- (v) **Existence:** Monopoly is an imaginary state of market structure. Pure monopoly is not found anywhere whereas oligopoly is a reality of the market and can be seen in abundance.
- (vi) **Profit:** A monopoly firm always earns super profit in the long-run but under oligopoly it is not possible unless there are strong barriers to the new entrants.
- (vii) **Demand Curve:** Under monopoly, demand curve is determinate whereas under oligopoly demand curve of a firm is indeterminate.
- (viii) **Price Rigidity:** Under oligopoly there is price rigidity but under monopoly it is not so.
- (ix) **Advertising Expenditure:** Under monopoly advertisement and sales promotion expenditure is much lower than oligopoly.



Price and Output Decisions under Oligopoly

Price and output decisions under oligopoly are different from other market situations. Here, the number of firms in the industry is very few, they are known to each other and their products are either homogeneous or slightly differentiated. Differentiated oligopoly is most common in practical life. Hence, there is strong interdependence among the rival firms. Interdependence of firms, uncertainty about rivals policies and mutual distrust make it impossible to arrive at determinate price-output solutions under oligopoly. There may be the following approaches of price determination under oligopoly.

1. **Independent Pricing or Pricing without Collusion:** It is a state of affairs where the rival firms decide upon an independent course of action and resort to independent pricing. Such a behavior stems from mutual distrust and antagonism among rivals. In this situation, business environment is full of uncertainty and



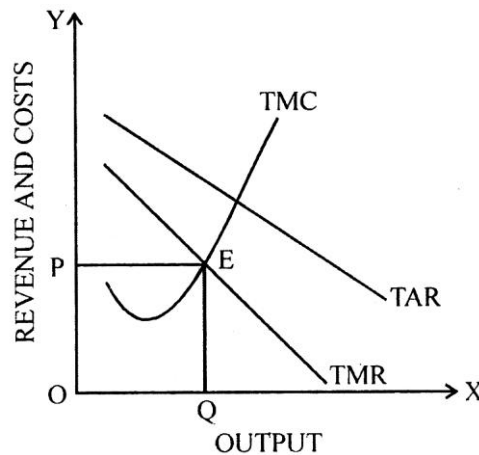
insecurity and price fluctuates between the two extreme of monopolistic price and competitive price but actual price, is based on prevailing situation in the market and nature of products, i.e., whether it is a homogenous or differentiated product.

If all oligopolist firms produce completely homogeneous products, the ultimate result will be uniform price. If any firm makes a price cut to enhance its market share, rivals will retaliate and sometimes more fiercely and there will thus be a price-war which may ruin all the firms. Similarly, if upward change in price by a firm is not reciprocated by the other rival firms, the customers may switch to other firms. Hence, under homogeneous oligopoly, there is a tendency of price stabilisation and each firm earns only normal profit. Under this type of oligopoly, firms try to enhance their market share by non-price competition. If there is product differentiation each firm enjoys some degree of monopoly and can make minor adjustments in price of his products, giving due consideration to price and output policies of rival firms. Here, the firms have greater opportunity to compete on the basis of product variations and promotional strategies.

Due to mutual rivalry, uncertainty and insecurity among the oligopolist firms under independent pricing, there is a tendency of these firms forwarding towards collusion and price leadership.

2. Price under Collusion: Collusion implies direct or indirect agreement among different firms in respect of price and output of the product. It is of two types: (i) Perfect Collusion and (ii) Imperfect Collusion.

(i) Perfect Collusion: Under it individual firms are not free to determine their price and output. In this, a cartel is formed which is given the right of price and output decisions for all the member firms. The cartel board determines the output quotas for members and the price they will charge, sometimes, sales area of each firm is also determined by the cartel. The aim is to eliminate competition and maximise the profits of member firms. Gradually the cartel takes the form of a monopolist; the market demand curve becomes the cartel's demand curve. Now, it becomes possible to get a determinate marginal revenue curve of the cartel which along with the combined marginal cost curve of the firms enables us to know determinate price-output solution. To obtain maximum joint profits for the firms, the cartel will choose that output at which industry's marginal cost curve (TMC) equals the industry's marginal revenue curve (TMR). This is shown in Fig. 31. In this figure, TAR is the demand curve for the whole industry, TMR is its total marginal revenue curve and TMC is its total marginal cost curve. TMC is intersecting TMR at point E. Hence, OQ quantity of products will be sold by the industry at OP price. Total profits of, the industry will be the maximum at this price.



Figure

There can be several forms of cartel, such as profit sharing cartel, market sharing cartel, etc. Under profit sharing cartel, the object is to get output at minimum cost. Hence, after determining the total quantity of output for the industry, each firm is assigned output quota in such a way that the marginal cost of producing the individual quota of output of each firm is the same. Sales and marketing functions are performed by the cartel and total profits of the industry are divided among the member firms on a certain pre-determined basis. In market sharing cartel, product market is clearly divided among the member firms of the group and each firm sells the product in his specified area at a uniform specified price. In this form of cartel, different member firms earn unequal profits due to the difference in their cost of production. Perfect collusion is a temporary and imaginary situation because differences among the member firms usually arise on sharing of quota of output and profits and so very soon some firms come out of the group. Besides, on entering new firms in the industry, state of perfect collusion is ended. Moreover, the government may also interfere to eliminate collusion.

(ii) Imperfect Collusion: Perfect collusion is an extreme case of collusive oligopoly. In real life, we find imperfect collusion. It is a state of gentlemen's agreement among all the firms in the industry in respect of price and output. Though the member firms have the right to make change in their price and outputs but in practice they have a tendency to work with mutual consent. Leadership is a most common form of imperfect collusion. There can be two types of leadership—price leadership and quantity leadership. Under quantity leadership, the leader takes up a lion's share of the market supply, leaving the rest to be shared by the followers.



Paper 2: Fundamentals of Accounting (FOA)

MATERIALS

Introduction

- ✦ The term materials refer to raw materials used for production, sub-assemblies and fabricated parts.
- ✦ Inventory means the raw materials, work-in-process goods and completely finished goods that are considered to be the portion of a business' assets that are ready or will be ready for sale.

Material Control

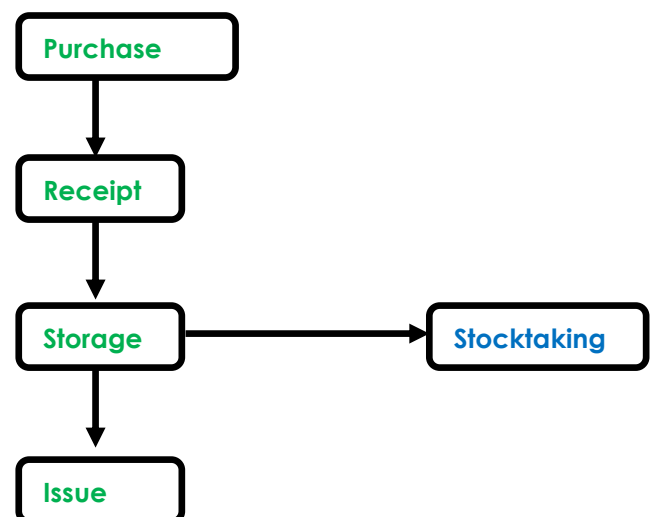
- ✦ Material Control aims at efficient purchasing of materials, their efficient storing and efficient use or consumption.

Objectives in a good system of material control can be:

- ✦ Materials of desired quality available when needed for efficient and uninterrupted production.
- ✦ Material to be purchased only when need exists and in economic quantities.
- ✦ Purchase of materials to be made at the most favorable prices under the best possible terms.
- ✦ Materials are protected against loss by fire, theft, etc.
- ✦ Materials should be stored in such a way that they provide minimum of handling and cost.

Material control Procedures

- Establishing optimal stock levels is of vital importance of in controlling of stock
- Once the optimal stock levels are established, the store department is responsible for ensuring that optimal stock levels are maintained for each item of materials in stock. Normally, a bin card is used to record the quantity of materials in stock for each item
- When items of materials have reached their re-order point, the storekeeper will make out a purchase requisition requesting the purchasing department to contact with appropriate supplier
- When the purchasing department receives the purchase requisition, the purchasing officer will examine the different sources of supply for the purpose of securing the highest quality materials at the lowest price
- On the receipt of the goods, the stores department will inspect and compare the supply with the purchase order
- When the departmental foreman receives a production order, he will give a materials requisition to the storekeeper. On the receipt of requisition, the storekeeper checks for correctness and authorisation. If





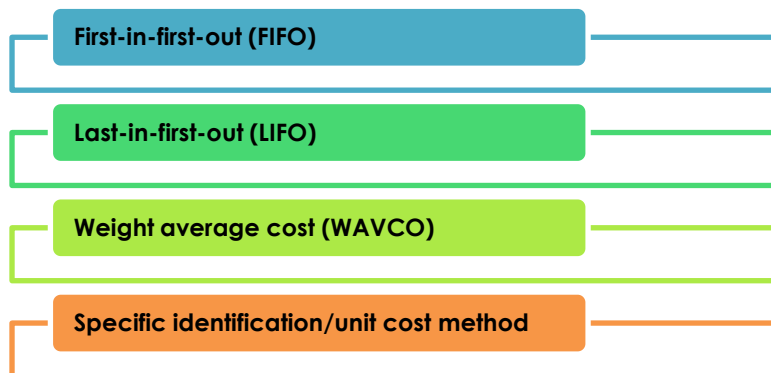
satisfactory, the issue will be made and entered the details in bin cards. He then forwards the store requisition to accounts department

- When the accounts department receives the stores requisition, it will price each of the items listed on it by appropriate pricing methods (e.g. FIFO etc). Then, the amount of materials issued is charged to appropriate job or overhead account and the stock values are reduced.

Pricing issues of material

- ❏ Pricing of materials may change from time to time.
- ❏ Materials are usually acquired by several deliveries at different prices.
- ❏ Actual costs can then take on several different values.
- ❏ Therefore, the materials pricing system adopted should be the simplest and the most effective one.

Methods of stock valuation



1. First-in-first-out

- This method assumes that the first stock to be received is the first to be sold.
- The cost of materials used is based on the oldest prices.
- The closing stock is valued at the most recent prices.



2. Last-in-first-out (LIFO)

- This method assumes that the last stock to be received is the first to be sold.
- Therefore, the cost of materials used is based on the most recent prices.
- The closing stock is valued at the oldest prices.



3. Weight average cost (WAVCO)

- This method assumes that the cost of materials used and closing stock are valued at the weighted average cost.

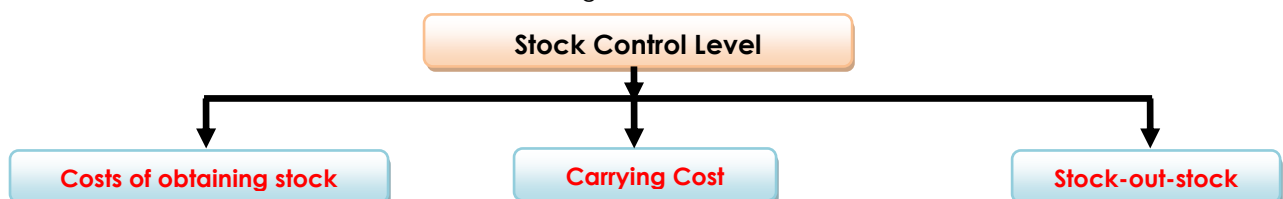


4. Specific identification/unit cost method

- This method assumes that each item of the stock has its own identity.
- The costs of materials used and closing stock are determined by associating the units of stock with their specific unit cost.

Stock control level

- The stores should control its stock at an appropriate level so as to minimize the costs related to stock
- These cost can be classified into three categories:





1. Cost of obtaining stock/ordering cost

- Purchase costs of goods acquired
- Carriage inwards
- Administrative costs of purchasing and accounts department

2. Stock-out cost

- Loss of sale revenue due to the stop in production
- Reduction in future sales because of the loss of goodwill
- Higher costs for urgent and small order of materials

3. Cost of storage (carrying cost)

- Storage and handling cost
- Interest on capital tied up by the stock
- Insurance and security
- Stock loss due to deterioration, obsolescence and pilferage
- Audit, stocktaking and stock recording cost

Economic Order Quantity (EOQ)

- ✦ EOQ is the order quantity that minimizes total inventory carrying costs and ordering costs.
- ✦ Ordering costs are costs that are incurred on obtaining additional inventories. They include costs incurred on communicating the order, transportation cost, etc.
- ✦ Carrying costs represent the costs incurred on holding inventory in hand. They include the opportunity cost of money held up in inventories, storage costs, spoilage costs, etc.

$$EOQ = \sqrt{\frac{2 \times O \times Q}{C}}$$

Where EOQ = Economic Order Quantity

O = Order Cost Per Order

Q = Annual quantity required in units

C = carrying cost per unit per annum

Example:



- ❖ The annual consumption of a part "X" is 5000 units. The procurement cost per order is ₹10 and the cost per unit is ₹ 0.5. The storage and carrying cost is 10% of the material unit cost.

Required:

Calculate the EOQ

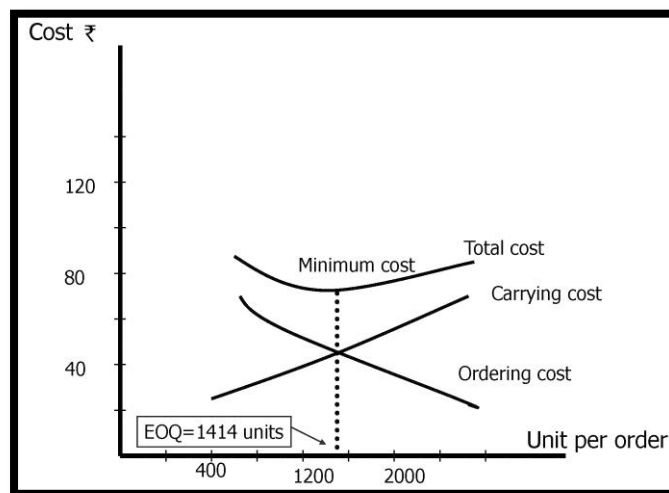
Solution:

❖ $O = ₹10$ $Q = 5000$, $C = ₹ 0.5 \times 10\%$

$$EOQ = \sqrt{\frac{2 O Q}{C}}$$

$$EOQ = \sqrt{\frac{2 \times 5000 \times 10}{0.5 \times 10\%}}$$

= 1414 units



- ❖ The graph shows the line representing ordering cost sloping downward, indicating lower cost when a large quantity is purchased and the line representing cost of carrying stock going upward, indicating a higher cost for a large quantity

Level setting

- It is to determine the correct or most optimal stock level so as to avoid overstocking or under-stocking of materials.
- These levels are known as the Maximum, Minimum and Re-order levels.

Re-order level

- The level of stock of material at which a new order for the material should be placed.
- The formula:
- Re-order level

= (Maximum usage × Maximum lead time)

Re-order Quantity

- Reorder quantity is the size of each order
- The formula:

Reorder Quantity = Maximum stock – (Reorder level – Minimum usage in minimum lead time)



Maximum level

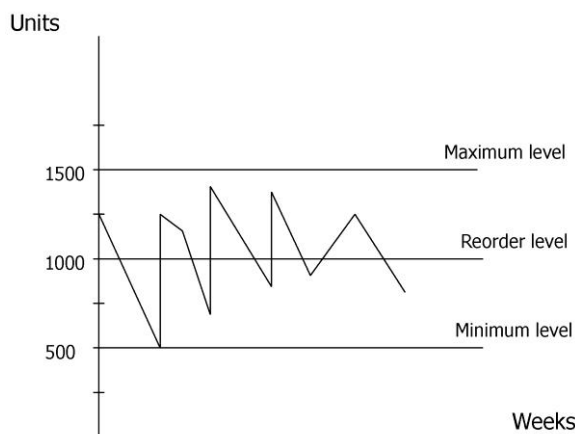
- The maximum stock level is highest level of stock planned to be held.
- Any amount above the maximum level will be considered as excessive stock.
- The formula:

Maximum level = Re-order level + Re- order quantity (EOQ) – Min anticipated usage in Minimum lead

Minimum level/Safety stock

- The minimum level is that level of stock that provides a safety buffer in the event of increased demand or reduced receipt of stock caused by the lengthening of lead time.
- The stock level should not be allowed to fall below the safety stock.

Minimum level = Re-order level – Average usage in average lead time



Example:



Average usage	1000 units per day
Minimum usage	800 units per day
Maximum usage	1350 units per day
Order Quantity	9000 units

Delivery reliably expected at the beginning of the fourth day.

Find the three control levels.

Solution:

1. Re-order level

$$\begin{aligned}
 &= (\text{Maximum consumption} \times \text{Maximum re-order period}) \\
 &= 1350 \text{ units} \times 4 \\
 &= 5400 \text{ units}
 \end{aligned}$$





2. Minimum level

= Re-order level – Average usage in average lead time

$$= 5400 \text{ units} - (800 \text{ units} \times 4)$$

$$= 2200 \text{ units}$$

3. Maximum level

= Re-order level + EOQ – Minimum anticipated usage in Minimum lead

$$= 5400 \text{ units} + 9000 \text{ units} - (800 \text{ units} \times 4)$$

$$= 11200 \text{ units}$$

Example:

Average usage	100 units per week
Minimum usage	70 units per week
Maximum usage	140 units per week
Lead time (the time between ordering and replenishment of goods)	3-5 weeks
Ordering cost per order	₹180
Annual cost of carrying a unit in stock	₹ 5.2

Calculate:

1. Economic Order Quantity (EOQ)
2. Reorder level
3. Reorder quantity
4. Minimum level
5. Maximum level



Solution:

1. Economic Order Quantity (EOQ)

$$EOQ = \sqrt{\frac{2 O Q}{C}}$$

$$EOQ = \sqrt{\frac{2 \times ₹180 \times 5200}{5.2}}$$

$$= 600 \text{ units}$$

2. Reorder level

Re-order level

$$= (\text{Maximum consumption} \times \text{Maximum re-order period})$$

$$= 140 \text{ units} \times 5$$

$$= 700 \text{ units}$$





3. Minimum level

Minimum level

= Re-order level – Average usage in average lead time

= 700 units – (100 units × 4)

= 300 units

4. Maximum level

Maximum level

= Re-order level + EOQ – Minimum anticipated usage in Minimum lead

= 700 units + 600 units – (70 units × 3)

= 1090 units

5. Reorder quantity

Reorder quantity = Maximum stock – (Re-order level – Minimum usage in minimum lead time)

= 1090 units – (700 units – 70 units × 3)

= 600 units





Paper 3: Fundamentals of Laws and Ethics (FLE)

INDIAN PARTNERSHIP ACT, 1932

Section 4 says "Partnership is the relation between persons who have agreed to share the profits of a business carried on by all or any of them acting for all."



Essentials of a Partnership:

1. Association of two or more persons.
2. Agreement
3. Business
4. Sharing of profits
5. Mutual Agency

Definitions:

Partner: Persons who have entered into partnership with one another are called individually 'partners'.

Firm: Collectively all the partners are called a 'firm'.

Firm name: The name under which their business is carried on is called the 'firm name'.

Maximum Limit on number of Partners:

- a) In case of a partnership firm carrying on a banking business – 10
- b) In case of a partnership firm carrying on any other business – 20.

Classification of Partnership:

- a) Particular Partnership
- b) Partnership at will



Partnership Deed:

- a) Name of the firm
- b) Names and addresses of partners
- c) Nature and place of business
- d) Commencement and duration of partnership.
- e) Capital contribution of each partner.
- f) Profit sharing ratio.
- g) Interest on capital and drawings.
- h) Rights, powers and duties of partners.
- i) Method of valuation of goodwill.
- j) Method of valuation of assets on retirement or death of a partner.

Types of Partners:

- Actual/ Active partner
- Sleeping/ Dormant partner
- Nominal partner
- Partner in profits only (example- minor partner)*
- Sub-partner

Position of a Minor as a Partner:

- (a) Before the admission of a minor as a partner, there must be an existence of partnership.
- (b) There must be mutual consent of all the partners.
- (c) A minor can be admitted only to the benefits of partnership.
- (d) There cannot be a partnership consisting of all the minors or of one major and all other minors.
- (e) Within 6 months of his attaining majority, the minor partner has to exercise his option whether or not to become a partner.

Registration of Partnerships:

Under the Act the registration of a firm is not compulsory but is desirable. As the registration is not compulsory, it can be affected at any stage.

Effects of non-registration:

- (i) No suit by a partner against the firm or other partner.
- (ii) No suit by the firm against third parties.



Duties of partners:

1. To attend diligently.
2. Not to claim remuneration for taking part.
3. To contribute equally to the losses.
4. To indemnify the firm for loss caused by his willful neglect or by his fraud.
5. To hold and use firm's property for business purpose.
6. To account for and pay the personal profits from transactions of firm.
7. Not to carry on a competing business.
8. To account for and pay the personal profits from a competing business.

Dissolution of partnership	Dissolution of firm
<ul style="list-style-type: none">• Old partnership comes to an end and a new partnership comes into existence.• The business continues under firm's name.• All the assets are revalued.	<ul style="list-style-type: none">• Old partnership comes to an end but no new partnership is formed.• The business does not continue under firm's name.• Under firm's dissolution all the assets are realized.

Modes of dissolution of a Firm:

- A. By an order of the court.
- B. Without the order of the court
 1. Dissolution by mutual agreement.
 2. Compulsory dissolution (Insolvency, Unlawful)
 3. Dissolution on the happening of a contingency (expiry of term, completion of term, death of a partner)
 4. Dissolution by notice

Dissolution by order of the Court

The Court may, on the receipt of petition by a partner, order for dissolution on the following grounds:

1. Insanity
2. Permanent incapacity
3. Misconduct
4. Persistent breach of contract
5. Transfer of interest
6. Perpetual losses
7. Any other just and equitable ground



Paper 4: Fundamentals of Business Mathematics and Statistics (FBMS)

SETS AND VENN DIAGRAMS

Sets

A set is a collection of things.

For example, the items you wear is a set: these would include shoes, socks, hat, shirt, pants, and so on.



You write sets inside curly brackets like this:

{Socks, shoes, pants, watches, shirts ...}

You can also have sets of numbers:

- Set of whole numbers: {0, 1, 2, 3, ...}
Set of prime numbers: {2, 3, 5, 7, 11, 13, 17, ...}

Ten Best Friends

You could have a set made up of your ten best friends:

- {alex, blair, casey, drew, erin, francis, glen, hunter, ira, jade}

Each friend is an "element" (or "member") of the set (it is normal to use lowercase letters for them.)

Now let's say that alex, casey, drew and hunter play Soccer:

Soccer = {alex, casey, drew, hunter}

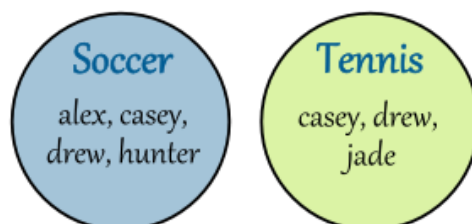
(The Set "Soccer" is made up of the elements alex, casey, drew and hunter).



And casey, drew and jade play Tennis:

Tennis = {casey, drew, jade}

You could put their names in two separate circles:





Union

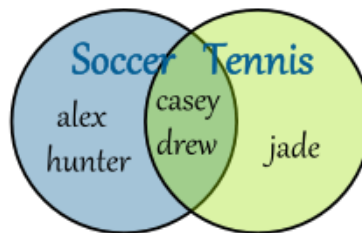
You can now list your friends that play **Soccer OR Tennis**.

This is called a "Union" of sets and has the special symbol u:

$$\text{Soccer } \cup \text{ Tennis} = \{\text{alex, casey, drew, hunter, jade}\}$$

Not everyone is in that set ... only your friends that play Soccer or Tennis (or both).

We can also put it in a "Venn Diagram":



Venn Diagram: Union of 2 Sets

A Venn Diagram is clever because it shows lots of information:

- Do you see that alex, casey, drew and hunter are in the "Soccer" set?
- And that casey, drew and jade are in the "Tennis" set?
- And here is the clever thing: **casey and drew are in BOTH sets!**

Intersection

"Intersection" is when you have to be in BOTH sets.

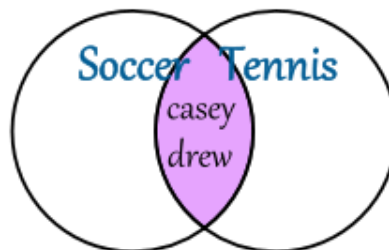
In our case that means **they play both Soccer AND Tennis** ... which is casey and drew.

The special symbol for Intersection is an upside down "U" like this: \cap

And this is how we write it down:

$$\text{Soccer } \cap \text{ Tennis} = \{\text{casey, drew}\}$$

In a Venn Diagram:



Venn Diagram: Intersection of 2 Sets

Which Way Does That "U" Go?
Think of them as "cups": u would hold more water than \cap , right?
So Union u is the one with more elements than Intersection \cap





Difference

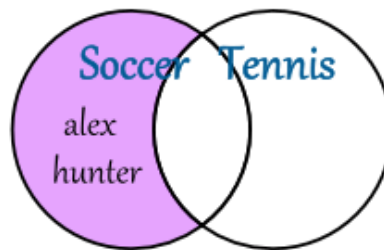
You can also "subtract" one set from another.

For example, taking Soccer and subtracting Tennis means people that **play Soccer but NOT Tennis** ... which is alex and hunter.

And this is how we write it down:

Soccer - Tennis = {alex, hunter}

In a Venn Diagram:



Venn Diagram: Difference of 2 Sets

Summary So Far

- U is Union: is in either set
- ∩ is Intersection: must be in both sets
- - is Difference: in one set but not the other

Three Sets

You can also use Venn Diagrams for 3 sets.

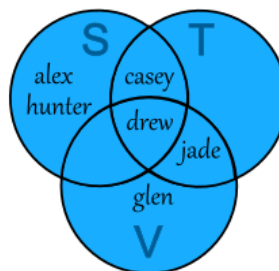
Let us say the third set is "Volleyball", which drew, glen and jade play:

Volleyball = {drew, glen, jade}

But let's be more "mathematical" and use a Capital Letter for each set:

- S means the set of Soccer players
- T means the set of Tennis players
- V means the set of Volleyball players

The Venn Diagram is now like this:



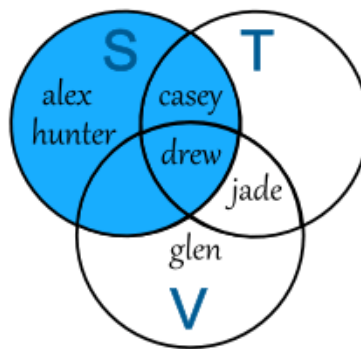
Union of 3 Sets: S ∪ T ∪ V



You can see (for example) that:

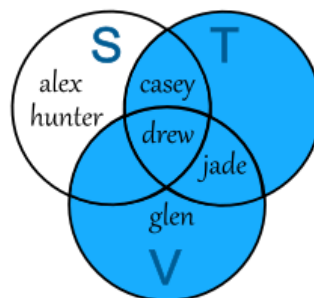
- drew plays Soccer, Tennis **and** Volleyball
- jade plays Tennis and Volleyball
- alex and hunter play Soccer, but don't play Tennis or Volleyball
- no-one plays **only** Tennis

We can now have some fun with Unions and Intersections...



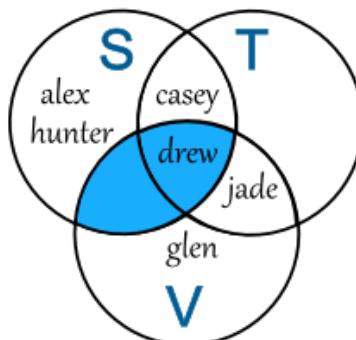
This is just the set S

$$S = \{\text{alex, casey, drew, hunter}\}$$



This is the Union of Sets T and V

$$T \cup V = \{\text{casey, drew, jade, glen}\}$$



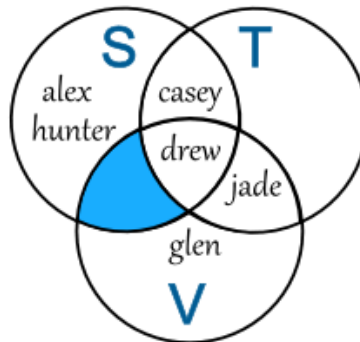
This is the **Intersection** of Sets S and V

$$S \cap V = \{\text{drew}\}$$



And how about this...

- take the **previous set** $S \cap V$
- then **subtract T**:



This is the Intersection of Sets S and V **minus** Set T
 $(S \cap V) - T = \{ \}$

Hey, there is nothing there!

That is OK, it is just the "Empty Set". It is still a set, so we use the curly brackets with nothing inside: { }

The **Empty Set** has no elements: { }

Universal Set

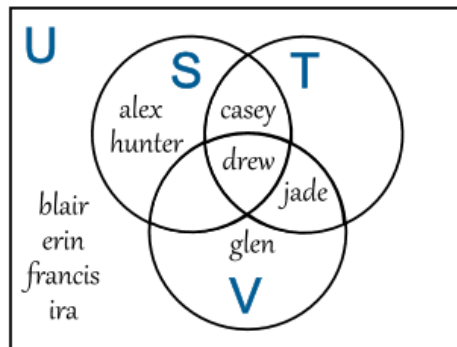
The **Universal Set** is the set that contains everything. Well, not exactly everything. **Everything that we are interested in now.**

Sadly, the symbol is the letter "U" ... which is easy to confuse with the u for Union. You just have to be careful, OK?

In our case the Universal Set is our Ten Best Friends.

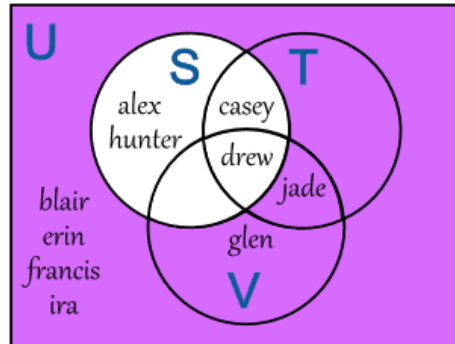
$$U = \{alex, blair, casey, drew, erin, francis, glen, hunter, ira, jade\}$$

We can show the Universal Set in a Venn Diagram by putting a box around the whole thing:



Now you can see ALL your ten best friends, neatly sorted into what sport they play (or not!).

And then we can do interesting things like take the whole set and **subtract the ones who play Soccer**:



We write it this way:

$$U - S = \{\text{blair, erin, francis, glen, ira, jade}\}$$

Which says "The Universal Set minus the Soccer Set is the Set {blair, erin, francis, glen, ira, jade}"
In other words "everyone who does **not** play Soccer".

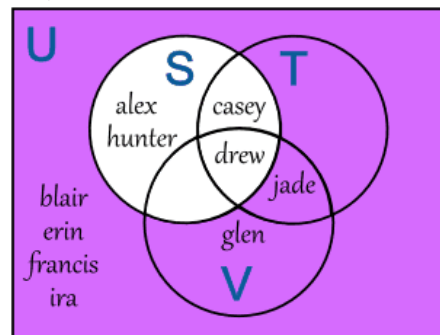
Complement

And there is a special way of saying "everything that is **not**", and it is called "**complement**".

We show it by writing a little "C" like this:

S^c

Which means "everything that is NOT in S", like this:



$$S^c = \{\text{blair, erin, francis, glen, ira, jade}\}$$

(just like the $U - C$ example from above)

Summary

- U is Union: is in either set
- \cap is Intersection: must be in both sets
- $-$ is Difference: in one set but not the other
- A^c is the Complement of A: everything that is not in A
- Empty Set: the set with no elements. Shown by $\{\}$
- Universal Set: all things we are interested in