1.1. Text#1 - PID control

A proportional–integral–derivative controller (PID controller or three-term controller) is a feedback-based control loop mechanism commonly used to manage machines and processes that require continuous control and automatic adjustment. It is typically used in industrial control systems and various other applications where constant control through modulation is necessary without human intervention. The PID controller automatically compares the desired target value (setpoint or SP) with the actual value of the system (process variable or PV). The difference between these two values is called the error value, denoted as ***e(t)***.

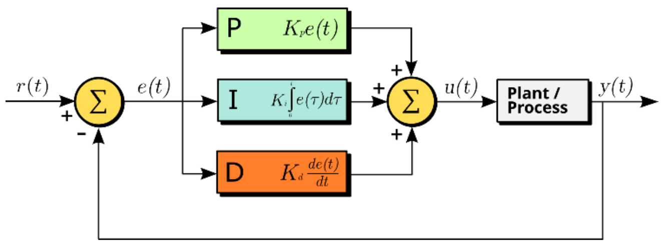


Figure 1- A block diagram of a PID controller in a feedback loop: ***r(t)*** is the desired process variable (PV) or setpoint (SP), and ***y(t)*** is the measured PV.

Fundamental operation

The distinguishing feature of the PID controller is the ability to use the three control terms of proportional, integral and derivative influence on the controller output to apply accurate and optimal control. The controller attempts to minimize the error over time by adjustment of a control variable ***u(t)***, such as the opening of a control valve, to a new value determined by a weighted sum of the control terms.

In this model:

- Term **P** is proportional to the current value of the SP − PV error ***e(t)***. For example, if the error is large, the control output will be proportionately large by using the gain factor "K_p". Using proportional control alone will result in an error between the set point and the process value because the controller requires an error to generate the proportional output response.
- Term **I** accounts for past values of the SP − PV error and integrates them over time to produce the **I** term. For example, if there is a residual SP − PV error after the application of proportional control, the integral term seeks to eliminate the residual error by adding a control effect due to the historic cumulative value of the error. When the error is eliminated, the integral term will cease to grow.
- Term **D** is a best estimate of the future trend of the SP − PV error, based on its current rate of change. It is sometimes called "anticipatory control", as it is effectively seeking to reduce the effect of the SP − PV error by exerting a control influence generated by the rate of error change. The more rapid the change, the greater the controlling or damping effect.

Mathematical form

The overall control function is given by: $$u(t) = K_p e(t) + K_i \int_0^t e(\tau)\,d\tau + K_d \frac{de(t)}{dt}, \quad (1)$$

where K_p, K_i and K_d, all non-negative, denote the coefficients for the proportional, integral, and derivative terms respectively (sometimes denoted *P*, *I*, and *D*).

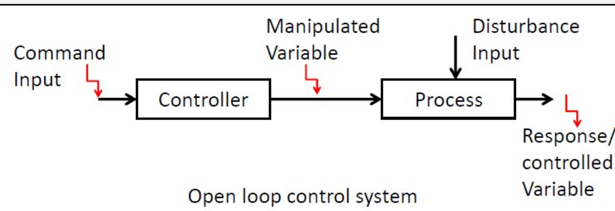
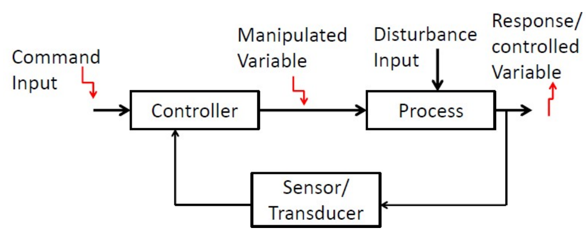
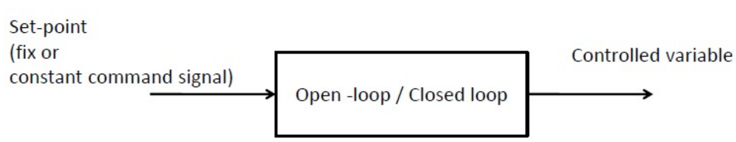
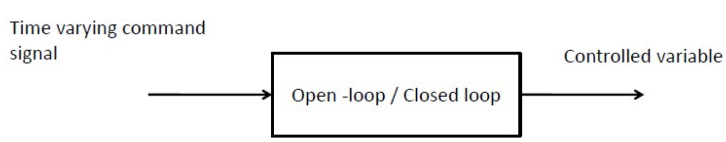
In the *standard form* of the equation K_i and K_d, are respectively replaced by **K_p / T_d** and **$K_p T_d$** ; the advantage of this being that T_i and T_d have some understandable physical meaning, as they represent an integration time and a derivative time respectively.
$K_p T_d$ is the time constant with which the controller will attempt to approach the set point.
K_p / T_d determines how long the controller will tolerate the output being consistently above or below the set point. Accordingly, equation (1) can be expressed as:

$$u(t) = K_p \left(e(t) + \frac{1}{T_i} \int_0^t e(\tau)\, d\tau + T_d \frac{de(t)}{dt} \right) \qquad (2)$$

Read the exte and answer the following Questions

1. What is the role of the proportional action ***P***?
2. What is the main condition on the PID parameters?
3. Give the word translation of equation (1) and (2).
4. Using your own words, explain the role of D action on the PID controller.

Terminologies

Notion	Explanation
Open loop control system- The controller acts on command signal to generate a manipulated variable. The function of this manipulated variable is to force the controlled variable to follow the command signal.	
Closed Loop Control or Feedback control system- Error signal is utilized by the controller to generate suitable control signal. •This control signal manipulates the signal to the process so that error reduces to zero (The error between the command and actual controlled variable).	
Regulator System - System in which controlled variable is maintained at set-point (i.e. fix or constant command signal) is called as regulator systems.	
Tracking systems / Command following System- When the command signal is changing with time and controller is used to make the controlled variable to follow the time-varying command signal.	

1.2. Text#1 – Introduction to robotics

Robotics is the intersection of science, engineering and technology that produces machines, called robots that replicate or substitute for human actions. Robots perform basic and repetitive tasks with greater efficiency and accuracy than humans, making them ideal for industries like manufacturing. However, the introduction of artificial intelligence in robotics has given robots the ability to handle increasingly complex situations in various industries.

1.2.1. Robot applications in our lives

Welding Considered as a dangerous task for a human because of toxic gases emissions.
Painting - has similar problems to welding due to the use of toxic chemical products.
Medical robot- The operation is more precise with fewer mistakes. Robot can open small incisions in the body and carry out major operations with minimal damage to the patient.
Mobile robot with legs or wheel- for chemical power plant, under see or remote areas and bombs fields.
Robotics aircrafts and boats without pilot which are guided from a station on the ground, which are used by army or rescue mission.

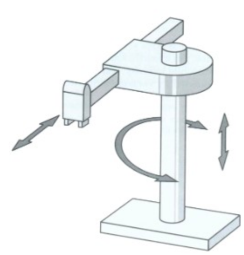
1.2.2. robot types

SCARA Robots - SCARA is an acronym that stands for Selective Compliance Assembly Robot Arm or Selective Compliance Articulated Robot Arm. SCARA Robots function on 3-axis (X, Y, and Z), and have a rotary motion as well.
Articulated Robots – Articulated Robots mechanical movement and configuration closely resembles a human arm. The arm is mounted to a base with a twisting joint. The arm itself can feature anywhere from two rotary joints up to ten rotary joints which act as axes, with each additional joint or axis allowing for a greater degree of motion. Most Articulated Robots utilize four or six-axis.

Cylindrical Robots- have a rotary joint at the base and a prismatic joint to connect the links. The robots have a cylindrical-shaped work envelop, which is achieved with rotating shaft and an extendable arm that moves in a vertical and sliding motion. Cylindrical Robots are often used in tight workspaces for simple assembly, machine tending, or coating applications due to their compact design.

Delta Robots - Delta Robots, or parallel robots, possess three arms connected to a single base, which is mounted above the workspace. Delta Robots work in a dome-shape and can move both delicately and precisely at high speeds due to each joint of the end effector being directly controlled by all three arms. Delta Robots are often used for fast pick and place applications in the food, pharmaceutical, and electronic industries.






1.2.3. Terminology

Word	**Translation**	**Meaning**
Arm	Bras	An interconnected set of links and powered joints.
Articulation or joint	Articulation ou junction	Describes a jointed device, such as a jointed manipulator. The joints provide rotation about a vertical axis, and elevation out of the horizontal plane.
Axis	Axe	A direction used to specify the robot motion in a linear or rotary mode.
AUV	Véhicule autonome sous-marin.	Autonomous underwater vehicle.
Base	Base	The fixed platform to which an industrial robotic arm is attached.
Cartesian Topology	Topologie cartésienne.	A topology, which uses prismatic joints throughout, normally arranged to be perpendicular to each other.
Degrees of Freedom	Degrés de liberté	The number of independent directions or joints of the robot which would allow the robot to move its end effector through the required sequence of motions.
DRONE	Drone	A general term for an autonomous vehicle, most commonly applied to unmanned aerial vehicles.
END-EFFECTOR	Outil terminal	The gripper or tool at the end of a robot arm designed to interact with the environment.
HUMANOID:	Humanoid	A robot with a subset of features designed to be similar to humans.
INVERSE KINEMATICS:	Géométrie inverse	A set of equations that describe how the joints of a robot should move to position the end-effector at a desired location in space. *See also "Singularity" and "XYZ Coordinates."*
MECHATRONICS	Mechatronics	A field that combines mechanical engineering, electrical engineering, and computer science to design robots and other intelligent machines.
Forward Kinematics	Géométrie directe	Computational procedures which determine where the end-effector of a robot is located in space.
Path	Trajectoire	The continuous locus of positions
Payload - Maximum	Charge maximale.	The maximum mass that the robot can manipulate at a specified speed, acceleration/deceleration, and repeatability under continuous operation over a specified working space
Pick-and-Place Task	Tache pick and place	A repetitive part transfer task composed of a picking action followed by a placing action.

- Explain, what is the role of robotic in our lives?
- Which robot faster than others?
- Write a paragraph in which you explain the future trends of robotics

1.3. Text#3- Overview on multivariable systems

Processes with only one output being controlled by a single manipulated variable are classified as **single-input single-output (SISO)** systems. Many processes, however, do not confirm to such a simple control configuration. In the industrial process for example, any unit operation capable of manufacturing or refining a product cannot do so with only a **single control loop**. In fact, each unit operation typically requires control over at least two variables. There are, therefore, usually at least two control loops to content with. Systems with more than one control loop are known as **multi-input multi-output (MIMO)** or **multivariable** systems.

By definition, **multivariable processes** or systems have more than one **input** variables or more than one **output** variables. Here below are a few examples of multivariable processes:

- A heated liquid tank where both the level and the temperature shall be controlled.
- A robot manipulator where the positions of the manipulators (arms) shall be controlled.
- A chemical reactor where the concentration and the temperature shall be controlled.

As second definition, multivariable system define a system in which the variables interact strongly. A disturbance in any input causes a change of response from at least one output.

A system with an equal number of inputs and outputs is said to be **square**.

A disturbance in any variable can cause a change in response in any output in its signal path. In most control system, a particular input **disturbance** cause one output to respond by a larger percentage than the other outputs. The response of the other output is called **interaction** which is often a result of system design and cannot be avoided.

A single-input single-output (SISO) feedback control system with the open-loop **transfer function** G(s) may be regarded, if N = 1, as a specific case of the MIMO system. The **transfer function** G(s) is a rational function in **complex** variable **s** and can be expressed as a quotient of two **polynomials** M(s) and D(s) with real coefficients:

$$G(s)=M(s)/D(s) \qquad (1)$$

where the **order *m*** of M(s) is equal to or less than the order ***n*** of D(s), that is we consider only physically feasible systems. From the classical control theory, we know that the **poles** p_i of G(s) are the **roots** of the denominator polynomial D(s), and **zeros** z_i are the **roots** of the numerator polynomial M(s). In the case of usual SISO systems with real parameters, complex poles and zeros always occur in complex **conjugate** pairs. Obviously, at the **zeros** z_i, the transfer function G(s) vanishes and, at the poles p_i, it tends to infinity (or 1/G(s) vanishes).

A special case of control problem can be reduced to controlling a single "**control variable**" with a single "**manipulated variable**". The two are assumed to be related via some simple (linear) dynamics, for example, a transfer function:

$$\mathbf{Y}(\mathbf{s}) = \mathbf{G}(\mathbf{s})\mathbf{U}(\mathbf{s}), \quad \text{where } \mathbf{Y}, \mathbf{G}, \mathbf{U} : \mathbb{C} \mapsto \mathbb{C}. \qquad (3)$$

However, in most cases, a system has more than one manipulated variable and more than one control input, and the interactions between these are such that the model cannot be further reduced.

That is, a system in which the input and the output are vectors, rather than scalars, is a MIMO system, or a multivariable system. When a MIMO system can be represented by a linear time invariant (**LTI)** model, we can use an external representation that extends the idea of a transfer matrix function:

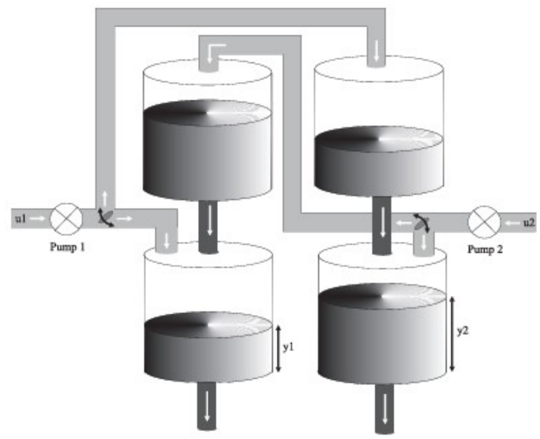
$$\begin{bmatrix} Y_1(s) \\ Y_2(s) \\ \vdots \\ Y_q(s) \end{bmatrix} = \begin{bmatrix} G_{11}(s) & G_{12}(s) & \cdots & G_{1p} \\ G_{21}(s) & G_{22}(s) & \cdots & G_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ G_{q1}(s) & G_{q2}(s) & \cdots & G_{qp} \end{bmatrix} \begin{bmatrix} U_1(s) \\ U_2(s) \\ \vdots \\ U_p(s) \end{bmatrix} \quad (3)$$

with **Y**$\in C^q$, **U**$\in C^p$, and **G**$\in C^{q\times p}$.

Example- The four tank apparatus is a laboratory system useful to study MIMO systems. It is a system with two inputs (the flows u_1 and u_2 provided by the pumps) and two outputs (the levels y_1 and y_2 of the two lower tanks)
At a suitable operating point, the system can be described by the transfer matrix:

$$G(s) = \begin{bmatrix} \frac{3.7\gamma_1}{62s+1} & \frac{3.7(1-\gamma_2)}{(23s+1)(62s+1)} \\ \frac{4.7(1-\gamma_1)}{(30s+1)(90s+1)} & \frac{4.7\gamma_2}{90s+1} \end{bmatrix}$$

The poles of a multivariable system are the poles of the elements of the transfer matrix.



Questions –
1. State three particular specifications of multivariable systems.
2. Give another mathematical form of equation (3)
3. In case of SISO system, explain the form of the poles and zeros.
4. Give a synonym of the following words: input, output, interaction.
5. Develop the equation (3) to get the general polynomial form.

Terminology-

English	Translation	explanation
Absolute value	Valeur absolue	$\|x\|$
Complex conjugate	Complexe conjugé	X1=a+ib and x2=a-ib
Even function	Function paire	
Exponent	Exponnetiel	X^4 : X exponent 4.
Expression	Expression ou formule	A mathematical phrase including numbers and/or *variables* with or without operations (e.g.,8 + 7, 7*x* – *y*).
Mean	Moyenne	
Set	Ensemble	
Square root	Racine carrée	√*a*
proper subset / strict subset	Sous-ensemble	A ⊂ B
not element of	N'appartient pas	*x*∉A

1.4. Terminologies

1.4.1. Robotics

There are many different terms surrounding the world of robotics. Some are straight forward, while others are more complex to understand. Having an understanding of robot terminology is useful for learning about robot components, their operation, and robotic manufacturing in general. The following are some of the most important terms in robotics.

- Articulated - A type of industrial robot with rotary joints.
- Horizontal Reach - This robot specification refers to the distance from the center of the robot to the end of the robot wrist when the robot arm is fully extended.
- Vertical Reach - This refers to the distance from the base of the robot to the end of the robot wrist when the arm is fully extended upward.
- Repeatability - This term refers to an industrial robot's ability to return to the same position over and over. In other words, it is how consistent a robot's movement may be.
- End-Effector - Is any tool or device that can be attached to a robot's wrist in order for a robot to perform a desired task. This term is often interchanged with end-of-arm-tooling (EOAT).
- Gripper - This is a type of end-effector used for the handling, holding, or manipulating of objects. These can vary in design from finger, magnetic, or vacuum styles.
- Payload - This is the maximum amount of weight a robot's wrist can lift. It is expressed in kilograms. A lot of the models contain the payload in their model number.
- Workpiece - This term is often used in robotics to describe an unfinished part that is manufactured or worked on by a robot.
- Work Envelope - This is the volume of space a robot can operate within. In other words, it is the robot's range of motion that is determined by its reach and axes.
- Uptime - This is the amount of time in which a robot is either operating or able to operate.
- Degrees of Freedom - The number of independent motions of a robot. Robotic degrees of freedom are determined by the number of axes a robot has.
- Joints - Sections of a robot's arm that allow for movement or rotation.
- Robotic Application - Robotic applications are the processes and tasks automated by a robot. Common applications include arc welding, assembly, pick and place, and palletizing.
- Manipulator - A sequence of link and joint connections used to manipulate parts without direct contact from an operator. The robot manipulator can be divided into the arm and robot body.
- Tool Changer - A device that is utilized when multiple end-effectors are used with the same robot. A robotic tool changer can automatically switch a robot's EOAT between cycle runs.
- Actuator - A robotic mechanism responsible for creating motion or controlling the robot, such as a motor. An actuator responds to a signal received from the control system.
- Structure - This is the design of an industrial robot. There are many different structures with the most common being articulated. Others include Delta, SCARA, and Gantry.

1.4.2. Control systems

System: A combination or arrangement of a number of different physical components to form a whole unit such that that combining unit performs to achieve a certain goal.

- **Control**: The action to command, direct or regulate a system.
- **Plant or process**: The part or component of a system that is required to be controlled.
- **Input**: It is the signal or excitation supplied to a control system.
- **Output:** It is the actual response obtained from the control system.
- **Controller**: The part or component of a system that controls the plant.
- **Disturbances**: The signal that has adverse effect on the performance of a control system.
- **Control system**: A system that can command, direct or regulate itself or another system to achieve a certain goal.
- **Automation**: The control of a process by automatic means Control System: An interconnection of components forming a system configuration that will provide a desired response.
- **Actuator**: It is the device that causes the process to provide the output. It is the device that provides the motive power to the process.
- **Design**: The process of conceiving or inventing the forms, parts, and details of system to achieve a specified purpose.
- **Simulation**: A model of a system that is used to investigate the behavior of a system by utilizing actual input signals.
- **Optimization**: The adjustment of the parameters to achieve the most favorable or advantageous design. Feedback Signal: A measure of the output of the system used for feedback to control the system. Negative feedback: The output signal is feedback so that it subtracts from the input signal.
- **Block diagrams**: Unidirectional, operational blocks that represent the transfer functions of the elements of the system.
- **Signal Flow Graph** (SFG): A diagram that consists of nodes connected by several directed branches and that is a graphical representation of a set of linear relations.
- **Open-loop control system**: A system that utilizes a device to control the process without using feedback. Thus the output has no effect upon the signal to the process.
- **Closed-loop feedback control system**: A system that uses a measurement of the output and compares it with the desired output.
- **Regulator**: The control system where the desired values of the controlled outputs are more or less fixed and the main problem is to reject disturbance effects.
- **Servo system**: The control system where the outputs are mechanical quantities like acceleration, velocity or position.
- **Stability**: It is a notion that describes whether the system will be able to follow the input command. In a non-rigorous sense, a system is said to be unstable if its output is out of control or increases without bound.
- **Multivariable Control System**: A system with more than one input variable or more than one output variable.

1.5. Classification

1.6. Natural control system and Man-made control system:

- **Natural control system**: It is a control system that is created by nature, i.e. solar system, digestive system of any animal, etc.

- **Man-made control system**: It is a control system that is created by humans, i.e. automobile, power plants etc.

1.7. Automatic control system and Combinational control system.

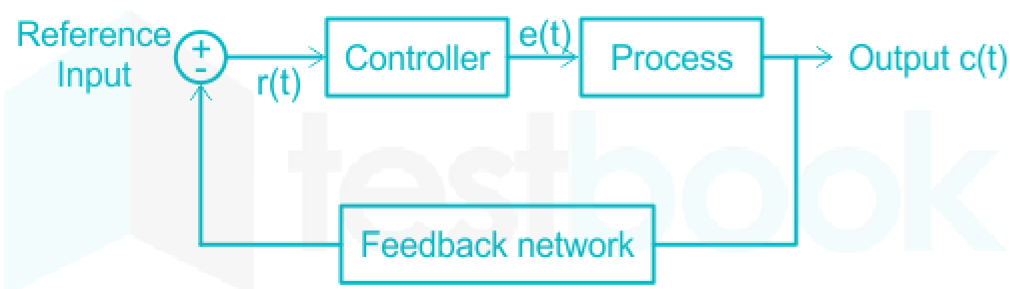
- **Automatic control system**: It is a control system that is made by using basic theories from mathematics and engineering. This system mainly has sensors, actuators and responders.
- **Combinational control system**: It is a control system that is a combination of natural and man-made control systems, i.e. driving a car etc.

1.8. Time-variant control system and Time-invariant control system:

- **Time-variant control system**: It is a control system where any one or more parameters of the control system vary with time i.e. driving a vehicle.
- **Time-invariant control system: It is a control system where none of its parameters vary with time i.e.** control system made up of inductors, capacitors and resistors only.

1.9. Components of Closed Loop Control System

A closed loop control system comprises several key components, each serving a specific function:



- Reference Input: The desired output or set point.
- Feedback Element: Measures and sends the actual output value back to the system.
- Error Detector: Compares the feedback with the reference input to identify the error.
- Controller: Adjusts the input to the process based on the error signal.
- Actuator: Executes the controller's adjustments to influence the output.
- Process (Plant): The system or device being controlled

Annex

1.10. Mots de transition pour ajouter des informations.

Il est souvent nécessaire d'ajouter des informations pour soutenir ou développer un point lors de l'écriture ou de la parole. Les mots de transition peuvent faciliter cette tâche. Les expressions telles que “in addition”, “furthermore” ou “moreover” sont particulièrement utiles dans ce contexte.

additionally	first, second, third, etc.	likewise
also	following this further	moreover
and	further	not only …, but also …
and then	furthermore	not to mention
as well, as well as	in addition	or
besides, besides that	indeed	then, too
equally important	in fact	too
finally	last, lastly	what is more

Après avoir exploré ces mots de transition, voyons maintenant comment les mots de transition peuvent être utilisés pour donner des exemples spécifiques.

1.11. Mots de transition pour donner des exemples spécifiques.

Lorsqu'il s'agit de prouver un point ou d'illustrer une idée, les exemples sont souvent nécessaires. Les mots de transition comme "for instance", "for example", ou "such as" sont couramment utilisés pour introduire ces exemples.

especially	notably
for example, an example	on this occasion
for instance	particularly, in particular
in this case, in another case	specifically
in this situation	take the case of
including	to demonstrate
namely	to illustrate, as an illustration

Maintenant que nous avons examiné les mots de transition pour donner des exemples, passons à ceux qui aident à clarifier les informations présentées.

1.12. Mots de transition pour clarifier des informations présentées.

Pour assurer une communication claire et efficace, il peut être nécessaire de clarifier ou de reformuler certaines informations. Les mots de transition tels que "in other words", "to put it simply", ou "that is to say" sont utiles dans ces cas.

I mean	that is to say	under certain circumstances
in other words	to put it another way	up to a point
in this case		

Après avoir considéré les mots de transition qui clarifient les informations, voyons comment certains mots peuvent mettre l'accent sur des informations spécifiques.

1.13. Mots de transition pour mettre l'accent sur des informations

Certains points ou idées méritent d'être mis en avant pour souligner leur importance. Les mots de transition tels que "indeed", "in fact", ou "particularly" peuvent aider à mettre l'accent sur ces points.

above all	extremely	obviously
absolutely	forever	surprisingly
always	in any case	that is
as a matter of fact	in any event	undeniably
besides	indeed	undoubtedly
certainly	in fact	unquestionably
definitely	more importantly	without a doubt
emphatically	naturally	without reservation
even more	never	

Passons maintenant aux mots de transition qui présentent une relation de cause à effet.

1.14. Mots de transition pour présenter une relation de cause à effet.

Expliquer les relations de cause à effet est un aspect essentiel de la communication claire. Les mots de transition tels que "therefore", "as a result", ou "consequently" sont utiles pour établir ces liens.

accordingly	for
as, as a result	for the simple reason that, for

	this reason
because, because of	hence
being that	inasmuch as
consequently, as a consequence	in that
due to (the fact that)	in view of (the fact that)
owing to (the fact that)	so that
seeing that	therefore
since	thus
so, so much (so) that	

Passons maintenant aux mots de transition qui aident à comparer ou contraster des informations.

1.15. Mots de transition pour comparer ou contraster des informations.

Pour montrer les similitudes et les différences entre les idées, nous avons besoin de mots de transition spécifiques. Les mots comme "however", "on the other hand", ou "similarly" peuvent être d'une grande aide.

after all	nevertheless
although, although this is true	nonetheless
at the same time	notwithstanding
balanced against	on the contrary
but	on the other hand
compared to/with, in/by comparison	similarly
conversely	still
for all that	when in fact
however	where

in contrast	whereas
in the same manner/way	while this is true
likewise	yet
meanwhile	

Après avoir exploré ces mots, nous passerons ensuite aux mots de transition qui indiquent des relations temporelles.

1.16. Mots de transition pour indiquer des relations temporelles.

Pour indiquer quand une action a lieu ou pour montrer une séquence d'événements, nous utilisons des mots de transition temporels comme "before", "after", "while", ou "meanwhile".

after, after a while	initially
afterwards	in the first place
as soon as	in the future
at first, at last, at the same time	in the meantime
before, before long, before this	last, last but not least, lastly
currently	later
during	meanwhile
eventually	next
finally	previously
first of all, first, second, third, etc.	simultaneously
formerly,	soon, soon after
immediately	subsequently
immediately before, immediately following	then, and then
in the end	thereafter

Maintenant que nous avons discuté des mots de transition temporels, passons aux mots de transition qui introduisent un désaccord ou un conflit.

1.17. Mots de transition pour introduire un désaccord ou un conflit.

Dans les sections suivantes, nous allons explorer différents types de mots de transition que vous pouvez utiliser pour introduire un désaccord ou un conflit dans vos discours et vos écrits.

1.17.1. Faire une concession ou un compromis sur un point

Il est important d'être capable de faire des concessions ou des compromis dans un argument. Voici des mots qui peuvent être utilisés pour ce faire.

admittedly	given that	naturally
albeit	granted that, granting that	nevertheless
although	however	nonetheless
at least	I admit that	notwithstanding
be that as it may	in any event	still
but even so	in either event	though
even though	in the event that	yet

1.17.2. Rejet d'une déclaration ou d'un argument précédent

Il y a des moments où vous pouvez avoir besoin de rejeter une déclaration ou un argument précédent. Voici une liste de mots que vous pouvez utiliser dans ce contexte.

all the same	in any case	in the event that
besides	in any event	it may appear that
either way	in either case	rather
even if	in either event	regardless
whatever happens	whichever	

1.17.3. Souligner une contradiction

Souligner une contradiction peut être un moyen puissant de faire valoir votre point de vue. Voici quelques mots de transition qui peuvent être utilisés pour souligner une contradiction.

but	conversely	however	in spite of	when in fact
by way of contrast	despite	in contrast	instead	whereas

1.17.4. Indiquer des réserves

Il est parfois nécessaire d'exprimer des réserves dans un argument. Les mots suivants sont des outils utiles pour cela.

indeed	notwithstanding
nevertheless	regardless
nonetheless	

1.17.5. Indiquer une digression à un point précédent ou reprendre après une digression ou une interruption

Lorsque vous vous écartez d'un point ou que vous reprenez après une digression ou une interruption, vous pouvez utiliser les mots suivants.

anyway	at any rate	incidentally	to get back to the point
as I was saying	by the way	to change the topic	to return to the subject

1.17.6. Pointer des conditions

Parfois, il peut être nécessaire de souligner une condition dans votre argumentation. Les mots suivants sont utilisés pour cet effet.

although	if	if only	providing that
as/so long as	on (the) condition (that)	provided that	unless

Après avoir discuté de ces mots de transition pour introduire un désaccord ou un conflit, nous allons maintenant voir les mots de transition pour introduire une conclusion ou un résumé.

1.18. Mots de transition pour introduire une conclusion ou un résumé.

Lors de la présentation d'une conclusion ou d'un résumé, il est important d'utiliser des mots de transition pour signaler au lecteur ou à l'auditeur que vous êtes sur le point de conclure vos idées. Des mots de transition tels que "in conclusion", "in summary", ou "to sum up" sont souvent utilisés dans ce contexte.

accordingly	given these facts

all in all, all together	hence
as a result	in conclusion, to conclude
as I have said, as I stated	in short
as I have shown	on the whole
as indicated above/earlier	overall
as mentioned, as I mentioned	since
as noted earlier, as has been noted	so
as I have noted	summing up, in summary
briefly, in brief, to put it briefly	to summarize
by and large	then
consequently	therefore
finally	thus

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1.19. Application pratique des mots de transition

L'apprentissage des mots de transition n'est pas suffisant, il est également important de comprendre comment les utiliser dans un contexte réel.

Que ce soit dans les tâches de lecture, d'écoute, de prise de parole ou d'écriture, l'application adéquate des mots de transition peut rendre votre réponse plus fluide et plus convaincante.

Dans la section "*Speaking*", vous pouvez utiliser des mots de transition pour structurer votre réponse.

Par exemple, vous pouvez commencer par "Firstly" ou "Initially", puis passer à "Secondly" ou "Subsequently", et enfin conclure avec "To sum up" ou "In conclusion".