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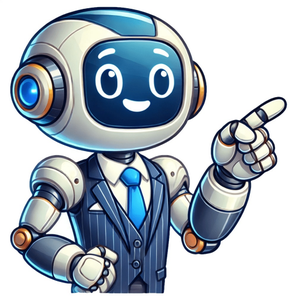

Transformers are vital components of electrical usage that transfer electrical energy from one electrical circuit to another. They change current to make it capable for an application. The typical transformer has two windings, with one being the primary winding which draws in energy, and the other being the secondary winding for transmitting this energy. Autotransformers have a different configuration with one winding serving as both the primary and secondary winding. This configuration is just as effective, but less expensive.Johnson Electric Coil Company is one of the primary companies for the production of transformers and produces single and three-phase autotransformers made of highly durable components to fit a wide range of applications. Their devotion to excellence and high-quality products includes both their in-stock autotransformers as well as ones they custom design to meet their customers unique requirements.What is an Autotransformer?Autotransformers have a single coil winding design. They are used to interconnect systems with single windings that perform as both the primary and secondary sides. In a two-winding transformer, there are two separate windings that are connected by a magnetic field, which provides an electrical isolation of the windings.An autotransformer has a single winding wrapped around a laminated core, which is used for the primary and secondary circuits. They have three terminals, one of the terminals is common to both input and the load. AC energy is supplied to the common and one of the other fixed terminals with the load connected to the common and the other fixed terminal.Aside from the AC connection between the windings, energy flows through induction because of the variations of the windings. The variation generates magnetic flux which, in turn, induces an EMF or self-induction. The two fixed points of the winding act as the primary while the winding between the tap point and one fixed point acts as the secondary.How Autotransformers Protect PeopleOne of the problems associated with long power lines is voltage drop, especially with applications that draw a great deal of current. Autotransformers are used to compensate for the drop in voltage in order to keep equipment operating at peak efficiency.Another, very common, use for autotransformers is in the starting of large AC motors to keep the potential voltage difference reduced at startup. Autotransformers hold the motor at the start-up level until the motor reaches 75% of its rated speed where the motor is then switched over to its full potential.Benefits of AutotransformersThere are an endless number of benefits to the use of autotransformers. Some of those benefits include:Save on Copper: Autotransformers use just one copper winding and, as a result, far less copper wire than traditional transformers of the same rating. This reduces the cost of manufacturing.Single Winding: The single winding of autotransformers reduces their size & weight, which gives them greater flexibility for use in a wide variety of applications.VA Rating: The smaller size and weight of autotransformers enables them to have a higher VA rating.Voltage Regulation: Since autotransformers have a single wind, they do not suffer a voltage loss due to the second winding.Efficiency: The second winding of a two winding transformer creates losses due to electrical conduction, magnetic induction, and reduction. Since an autotransformer does not have the second winding and subsequent losses, it operates more efficiently.Features of Our AutotransformersAutotransformers from Johnson Electric Coil have proven to be a major factor in providing our customers with a safe means of controlling electrical current. Our precision crafted autotransformers meet safety agency requirements for both domestic and international agency specifications.Range of ApplicationsThe convenience and adaptability of autotransformers makes them ideal for a wide variety of applications. They are more efficient at boosting the potential difference across a distribution line by a small fraction to compensate for power drop. This aspect of their operation is at a fraction of the cost for a two-winding transformer.Cost Effective and Highly EfficientAutotransformers cost less to produce but provide exceptional service. Johnson Electric Coils staff of highly trained specialists custom design autotransformers that are highly efficient made from the highest quality materials. Essentially, at a lower price, an autotransformer provides the same efficiency in a smaller, more compact package.Compact DesignSince there are fewer wires and a more streamline design, autotransformers are smaller and capable of being used in a wider assortment of equipment and applications. This flexibility makes them an ideal method for voltage output control.In certain applications, voltage control is a necessity to avoid harm to engines and components. Sending a full load into an application can be detrimental and requires precision control, which is engineered into every Johnson Electrical Coil autotransformer.Autotransformers ApplicationsThere are an endless number of uses for autotransformers from controlling the startup of large AC motors to controlling the potential voltage drop in distribution transformers to helping to set the perfect temperature for your morning coffee.Autotransformers are normally used in conditions where primary and secondary isolation is not necessary. Due to their size and compactness, they are used as household AC regulators and three phase motor auto decompression starter boxes.A common application for autotransformers is boosting the potential difference drop for distribution lines by a small fraction to compensate for the voltage drop in the line. Long power lines over long distances have a power drop due to the distance. Autotransformers step up the voltage to help maintain constant power.How to Choose an AutotransformerThere are several factors to consider when choosing an autotransformer. The critical factors include:KVA The size of an autotransformer is determined by the KVA of the load, which is dependent on the number of pieces of equipment being serviced. The anagram KVA stands for kilovolt ampere or thousand-volt ampere and should be equal to or greater than the KVA of the load.Supply Voltage The supply voltage is the line voltage from the local power source.Required Voltage It is important to determine the voltage required by the load, which is the output voltage of the autotransformer and is the voltage required to operate the load.Supply Source Frequency The frequency of the supply source and the load have to be the same.Custom Autotransformers at Johnson Electric CoilAfter making a complete assessment of your needs, you may find that you require a custom-designed autotransformer. Johnson Electric Coil Companys engineers and designers are ready to provide you with the necessary guidance and to develop an autotransformer that will precisely meet your needs. Maybe, youre still not quite sure what an autotransformer is exactly and how it can benefit your companys bottom line. Johnsons staff has the know-how, skill, and ability to meet your every need. Solar Power A Complete Guide About Solar Panel Installation. Step by Step Procedure with Calculation & Diagrams Below is a DIY (do Read More Transformer How to Calculate the Rating of Single Phase & Three Phase Transformers in kVA We know that atransformer is always Read More Batteries How to Calculate the Charging Time and Charging Current for Battery Charging? Easy Battery Charging Time and Battery Charging Current Read More Electrical Wiring Automatic UPS System Wiring Circuit Diagram (One Live Wire & Ordinary Wiring) Automatic UPS / Inverter Connections In case of Read More Electrical Energy Calculate Your Electricity Bill in 1 Minute with a Simple Calculation or by Using an Electric Energy Bill Calculator Calculating Read More Electrical Wiring How to Determine the Suitable Size of Wire and Cable or Electrical Wiring Installation? Examples in Imperial and Metric Systems Read More ,the free encyclopedia that anyone can edit.107,766 active editors 7,028,433 articles in EnglishLesley James McNair (25May 1883 25July 1944) was a lieutenant general of the United States Army who served in both world wars, and previously saw service in the Veracruz occupation and the Pancho Villa Expedition. During World WarI, he served with the American Expeditionary Forces on the Western Front. At 35, he became the Army's second-youngest general officer. During the early stages of World WarII, he was the commander of Army Ground Forces, and played the leading role in the organization, equipping, and training of Army units before they departed for overseas combat. He was killed on 25July 1944 while in France as commander of the fictitious First United States Army Group, part of Operation Quicksilver, a deception plan for the invasion of Normandy. McNair died when the US Eighth Air Force attempted to use heavy bombers in support of ground combat troops, and several planes dropped payloads short of their targets. He received a posthumous promotion to general. (Fullarticle...)Recently featured: Second Test, 1948 Ashes seriesDaily News BuildingHippocampusArchiveBy emailMore featured articlesAboutState flag of Transnistria... that the state flag of Transnistria (pictured) features communist symbols, even though Transnistria is not a communist state?... that actor Suja Khondokar served as a flight attendant aboard the inaugural commercial flight of Biman Bangladesh Airlines?... that Peru's fishing industry is the world's largest producer of fishmeal and fish oil?... that the Albanian noble Blasius Mataranga may have been captured and killed by the Balsha familyafter they lured him into peace talks with a false promise of safe conduct?... that Mayu Sakai found drawing Peter Pan Syndrome difficult because of its fantasy elements?... that American football player Bob Wicks was teammates with the same quarterback from fourth grade through college?... that from 1986 to 1988, a Boston TV station was the only one in the U.S. to broadcast digital audio in its video signal?... that Archbishop LetardII of Nazareth was one of only a few fellow bishops about whom William of Tyre had something nice to say?... that some Italians eat eggplants with chocolate?ArchiveStart a new articleNominate an articleOzzy OsbourneArmed clashes erupt in the CambodiaThailand border conflict.Ozzy Osbourne (pictured), the lead singer of Black Sabbath, dies at the age of 76.A fighter jet crashes into a college in Dhaka, Bangladesh, killing more than 30 people.In golf, Scottie Scheffler wins the Open Championship.Ongoing: Gaza warRussian invasion of UkrainetimelineSudanese civil wartimelineRecent deaths: Chuck MangioneHulk HoganThomas Anthony DurkinGiora EpsteinBatrice Uria-MonzonRex WhiteRoger NorringtonEdwin FeulnerNominate an articleJuly 25: National Day of Galicia, Saint James's Day, Tenjin MatsuriThe Concorde involved in the Air France Flight 4590 accident1261 Alexios Strategopoulos led Nicaean forces to recapture Constantinople, leading to the reestablishment of the Byzantine Empire and the end of the Latin Empire.1893 The Corinth Canal was formally opened, bisecting the narrow Isthmus of Corinth in Greece to connect the Ionian Sea's Gulf of Corinth with the Aegean Sea's Saronic Gulf.1950 Korean War: After American troops withdrew, North Korean forces captured the village of Yongdong in South Korea.2000 Air France Flight4590 (plane used pictured), a Concorde en route from Paris to New York, crashed in Gonesse, France, killing all 109 passengers on board and four people on the ground.2010 WikiLeaks published 75,000 classified documents about the War in Afghanistan in one of the largest leaks in U.S. military history.Sibylla, Queen of Jerusalem (d.1190)Matt LeBlanc (b.1967)Meg Donnelly (b.2000)Azimzhan Askarov (d.2020)More anniversaries: July 24July 25July 26ArchiveBy emailList of days of the yearAboutThe Carousel at Glen Echo ParkAmusement rides on the National Register of Historic Places (NRHP) are located throughout the United States. These individual ride listings consist mainly of carousels, but also include roller coasters, trains, and other ride types. Many NRHP-listed rides operate within amusement parks, with more than one present in Cedar Point, Lagoon, and Santa Cruz Beach Boardwalk. There are also high concentrations in New York City, the Greater Binghamton area in New York state, and Portland, Oregon. The first NRHP amusement ride listing was added in 1975 for the Idora Park Merry-Go-Round (delisted in 1985). The listing for the Crescent Park Looff Carousel was added in 1976 and is the ride that has existed on the NRHP the longest. The listing for the Portland Zoo Railway Historic District was created in 2020 and is the newest ride entry on the NRHP. Several NRHP-listed rides, including the Leap-the-Dips roller coaster, have a higher National Historic Landmark status. Of the nearly 100,000 NRHP listings, fewer than 100 are for amusement rides. (Fulllist...)Recently featured: One Direction discographyKerivoulinesAccolades received by InceptionArchiveMore featured listsHudson Yards is a 28-acre (11-hectare) real-estate development located in Hudson Yards, a neighborhood of the New York City borough of Manhattan. It is situated on the waterfront of the Hudson River, on a platform built over the West Side Yard, a storage depot for the Long Island Rail Road. Related Companies and Oxford Properties are the primary developers and major equity partners in the project, with the master plan designed by the architectural firm Kohn Pedersen Fox. Construction began in 2012 and the first phase opened in 2019, with completion of the second phase expected by 2032. Major office tenants in the development include Warner Bros. Discovery, L'Oral, and Wells Fargo among others. This photograph shows the skyscrapers of Hudson Yards, viewed across the Hudson River from Weehawken, New Jersey, in 2021.Photograph credit: Tony JinRecently featured: Emperor angelfishAmlia RodriguesAtari video game burialArchiveMore featured picturesCommunity portal The central hub for editors, with resources, links, tasks, and announcements.Village pump Forum for discussions about Wikipedia itself, including policies and technical issues.Site news Sources of news about Wikipedia and the broader Wikimedia movement.Teahouse Ask basic questions about using or editing Wikipedia.Help desk Ask questions about using or editing Wikipedia.Reference desk Ask research questions about encyclopedic topics.Content portals A unique way to navigate the encyclopedia.Wikipedia is written by volunteer editors and hosted by the Wikimedia Foundation, a non-profit organization that also hosts a range of other volunteer projects: CommonsFree media repository MediaWikiWiki software development Meta-WikiWikimedia project coordination WikibooksFree textbooks and manuals WikidataFree knowledge base WikinewsFree-content news WikiquoteCollection of quotations WikisourceFree-content library WikispeciesDirectory of species WikiversityFree learning tools WikivoyageFree travel guide WiktionaryDictionary and thesaurusThis Wikipedia is written in English. Many other Wikipedias are available; some of the largest are listed below. 1,000,000+ articles DeutschEspaolFranaisItalianoNederlandsPolskiPortugusSvenskaTing Vit 250,000+ articles Bahasa IndonesiaBahasa MelayuBn-lm-gCataletinaDanskEestiEsperantoEuskaraMagyarNorsk bokmlRomnSimple EnglishSloveninaSrpskiSrpskohrvatskiSuomiTrkeOzbekcha 50,000+ articles AsturianuAzrbaycancaBosanskiFryskGaeilgeGalegoHrvatskiKurdLatvieuLietuviNorsk nynorskShqipSloveninaRetrieved from " 2Calendar yearYearsMillennium2ndmillenniumCenturies12thcentury13thcentury 14thcenturyDecades1240s1250s1260s 1270s1280sYears1258125912601261 1262126312641vte1261 by topicLeadersPolitical entitiesState leadersReligious leadersBirth and death categoriesBirths DeathsEstablishments and disestablishments categoriesEstablishments DisestablishmentsArt and literature1261 in poetryvte1261 in various calendarsGregorian calendar1261MCCLXIAb urbe condita2014Armenian calendar710 Assyrian calendar6011Balinese saka calendar11821183Bengali calendar667668Berber calendar2211English Regnal year45Hen.346Hen.3Buddhist calendar1805Burmese calendar623Byzantine calendar67696770Chinese calendar (MetalMonkey)3958 or 3751to (MetalRooster)3959 or 3752Coptic calendar977978Discordian calendar2427Ethiopian calendar12531254Hebrew calendar50215022Hindu calendars- Vikram Samvat13171318- Shaka Samvat11821183- Kali Yuga43614362Holocene calendar11261Igbo calendar261262Iranian calendar639640Islamic calendar659660Japanese calendarBun' 2 / Kch 1()Javanese calendar11701171Julian calendar1261MCCLXIKorean calendar3594Minguo calendar651 before ROC651Nanakshahi calendar207Thai solar calendar18031804Tibetan calendar(male Iron-Monkey)1387 or 1006 or 234to(female Iron-Bird)1388 or 1007 or 235Michael VIII Palaiologos (12231282)Year 1261 (MCCLXI) was a common year starting on Saturday of the Julian calendar.March 13 Treaty of Nymphaeum: Emperor Michael VIII Palaiologos signs a trade and defense agreement with the Republic of Genoa, to counterweight the Venetian presence in the region. Genoa agrees to ally with the Empire of Nicaea, by providing a fleet of up to 50 galleys during the projected Nicaean siege of Constantinople, while 16 galleys are to be immediately sent against the Latin Empire.[1]July Michael sends his general Alexios Strategopoulos with a small advance force of 800 soldiers, most of them Cumans, to keep watch on the Bulgarians and scout the defending positions of the Latin forces in the surroundings of Constantinople. When they reach the village of Selymbria, Strategopoulos is informed by local farmers that the entire Latin garrison and the Venetian fleet, are absent conducting a raid against the Nicaean island of Daphnousia. He decides not to lose such a golden opportunity and makes plans (without the consent of Michael) to retake the capital.[2]July 25 Reconquest of Constantinople: Alexios Strategopoulos and his men hide at a monastery near the city gates, before entering through a secret passage. After a short struggle, the guards who are completely taken by surprise are killed and the Venetian quarter is set ablaze. Panic spreads through the capital and Emperor Baldwin II rushes out to save his life, evacuating along with many other Latins with the help of the Venetian fleet. Baldwin manages to escape to the still Latin-held parts of Greece, but Constantinople is lost for good.[3]August 15 Michael enters Constantinople in triumph and is crowned as emperor of the Byzantine Empire at the Hagia Sophia. To solidify his claim, the legitimate ruler, John IV Laskaris, is blinded on Michael's orders on December 25, his 11th birthday. Michael banishes him to a monastery and marries his two sisters to lesser Latin and Bulgarian nobles in an attempt to wipe out the Laskarid dynasty.[4]Kublai Khan releases 75 Chinese merchants who were captured along the border of the Mongol Empire. By doing this, Kublai hopes to bolster his popularity and depend on the cooperation of his Chinese subjects to ensure that his army receives more resources.[5]June 13 Al-Mustansir II becomes the first Abbasid ruler in Cairo (after his escape during the Siege of Baghdad). He is sent with an army by Sultan Baibars to recover Baghdad, but is killed in a Mongol ambush near Anbar (modern Iraq), on November 28. The Abbasid caliphs continue as religious figureheads for the Mamluks in Egypt until the 16th century.[6]June 12 King Henry III of England obtains a papal bull to absolve himself from his oath to maintain the Provisions of Oxford. He hires an army of 300 French knights as a bodyguard and takes up position in the Tower of London. He dismisses the baronial officials (led by Simon de Montfort) who wish the royal power to be modified by the principle of representation. This sets the stage for the Second Barons' War.[7]August Battle of Callann in Ireland: Norman forces under John FitzThomas are defeated by a Gaelic army led by King Fnghin Mac Carthaigh. John FitzGerald is killed during the fighting.[8]February The Japanese Bun' era ends and the Kch era begins during the reign of the 11-year-old Emperor Kameyama (until 1264).Early Following disputes, northern academics from the University of Cambridge in England set up a University of Northampton by royal charter but it is suppressed by the Crown in 1265.[9]The earliest extant Chinese illustration of "Pascal's Triangle" is from Yang Hui's (or Qianguang's) book Xiangjie Jiuzhang Suanfa, published this year.May 25 Pope Alexander IV dies after a pontificate of 6-years at Viterbo. He is succeeded by Urban IV as the 182nd pope of the Catholic Church.August 29 Urban IV offers the crown of Sicily to Charles of Anjou, youngest son of King Louis VIII of France, hoping to strengthen his position.Wurmsbach Abbey (located in Bollingen) is established by Count Rudolf V of Rapperswil in Switzerland.February 1 Walter de Stapledon, English bishop of Exeter (d. 1326)February 11 Otto III, Duke of Bavaria, king of Hungary and Croatia (d. 1312)February 28 Margaret of Scotland, queen consort of Norway (d. 1283)March 1 Hugh Despenser the Elder, English chief adviser (d. 1326)July 25 Arthur II, Breton nobleman (House of Dreux) (d. 1312)October 9 Denis I ("the Poet King"), king of Portugal (d. 1325)Abu Abdallah ibn al-Hakim, Andalusian vizier and poet (d. 1309)November 'Ala' al-Dawla Simnani, Persian Sufi mystic and writer (d. 1336)Albertino Mussato, Paduan statesman, poet and chronicler (d. 1329)Constantine Palaiologos, Byzantine prince and general, son of Michael VIII (d. 1306)Daniel of Moscow (Aleksandrovich), Russian prince (d. 1303)Zangpo Pal, Tibetan religious leader (d. 1323)Elizabeth of Sicily, queen consort of Hungary (House of Anjou) (d. 1303)Konoe Iemoto, Japanese nobleman (kugy) and regent (d. 1296)Pier Saccone Tarlati di Pietramala, Italian nobleman and condottiero (d. 1356)Wadysaw I okietek ("Elbow-High"), king of Poland (d. 1333)February 28 Henry III ("the Good"), duke of Brabant (b. 1230)April 1 Ahi Evran, Bektashi Sufi preacher and poet (b. 1169)May 25 Alexander IV, pope of the Catholic Church (b. 1199)July 8 Adolf IV of Holstein, German nobleman (House of Schaumburg)July 25 Nicephorus II of Constantinople, Byzantine patriarchAugust John FitzThomas, 1st Baron Desmond, Norman Irish nobleman, killed in battleAugust 24 Ela of Salisbury, English noblewoman (b. 1187)September 18 Konrad von Hochstaden, German archbishopSeptember 22/27 Plaisance of Antioch, queen consort of Cyprus (b. 1235)October 27 Sancho of Castile, Spanish archbishop (b. 1233)November 2 Bettisia Gozzadini, Bolognese noblewoman and academic lawyer (b. 1209)November 9 Sanchia of Provence, Queen of the Romans, German queen consort (b. 1225)November 26 Hj Shigetoki, Japanese samurai (b. 1198)November 27 Athanasius III of Alexandria, Egyptian popeNovember 28 Al-Mustansir II, Abbasid ruler (caliph) of Cairo, killedAbu Bakr Ibn Sayyid al-Ns, Andalusian theologian (b. 1200)An-Nasir Dawud, Kurdish ruler, Ayyubid ruler (emir) of Damascus (b. 1206)Benedict II of Esztergom, Hungarian chancellor, governor and archbishopConrad I, Burgrave of Nuremberg ("the Pious"), German nobleman and knight (b. 1186)Qin Jiushao, Chinese mathematician and writer (b. 1202)Sayf al-Din Bakharzi, Persian poet and sheikh (b. 1190)Stephen of Bourbon, French Dominican preacher (b. 1180)^ Steven Runciman (1952). A History of The Crusades. Vol III: The Kingdom of Acre, p. 240. ISBN978-0-241-29877-0.^ Bartusis, Mark C. (1997). The Late Byzantine Army: Arms and Society, 12041453, pp. 4041. University of Pennsylvania Press. ISBN0-8122-1620-2.^ Nicol, Donald M. (1993). The Last Centuries of Byzantium, 12611453, p. 35 (Second ed.). Cambridge: Cambridge University Press. ISBN978-0-521-43991-6.^ Hackel, Sergei (2001). The Byzantine Saint, p. 71 (2001 ed.). St. Vladimir's Seminary Press. ISBN0-88141-202-3.^ Rossabi, Morris (1988). Khubilai Khan: His Life and Times, p. 51. Los Angeles: University of California Press. ISBN978-0-520-06740-0.^ Lock, Peter (2013). The Routledge Companion to the Crusades. Routledge. p.112. ISBN9781135131371.^ Williams, Hywel (2005). Cassell's Chronology of World History. London: Weidenfeld & Nicolson. pp.144146. ISBN0-304-35730-8.^ BBC History, July 2011, p. 12.^ Lawrence, C. H. (1984). "The University in State and Church". In Aston, T. H.; Catto, J. I. (eds.). The History of the University of Oxford. Vol.1. Oxford University Press.Retrieved from " 3One hundred years, from 1101 to 1200See also: Renaissance of the 12th centuryMillennia2ndmillenniumCenturies11thcentury12thcentury13thcenturyTimelines11thcentury12thcentury13thcenturyState leaders11thcentury12thcentury13thcenturyDecades1100s1110s1120s1130s1140s1150s1160s1170s1180s1190sCategories:Births Deaths Establishments DisestablishmentsvteEastern Hemisphere at the beginning of the 12th centuryThe 12th century is the period from 1101 to 1200 in accordance with the Julian calendar. In the history of European culture, this period is considered part of the High Middle Ages and overlaps with what is often called the "'Golden Age' of the Cistercians". The Golden Age of Islam experienced significant development, particularly in Islamic Spain.In Song dynasty China, an invasion by Jurchens caused a political schism of north and south. The Khmer Empire of Cambodia flourished during this century, while the Fatimids of Egypt were overtaken by the Ayyubid dynasty. Following the expansions of the Ghaznavids and Ghurid Empire, the Muslim conquests in the Indian subcontinent took place at the end of the century.Main article: 1100sThe Ghurid Empire converted to Islam from Buddhism.1101: In July, the Treaty of Alton is signed between Henry I of England and his older brother Robert, Duke of Normandy in which Robert agrees to recognize Henry as king of England in exchange for a yearly stipend and other concessions. The agreement temporarily ends a crisis in the succession of the Anglo-Norman kings.11011103: David the Builder takes over Kakheti and Hereti (now parts of Georgia).1102: King Coloman unites Hungary and Croatia under the Hungarian Crown.1102: Muslims conquer Seoro de Valencia.11031104: A church council is convened by King David the Builder in Urbnisi to reorganize the Georgian Orthodox Church.1104: In the Battle of Ertsukhi, King David the Builder defeats an army of Seljuks.1104: King Jayawarsa of Kadiri (on Java) ascends to the throne.[citation needed]1106: Battle of Tinchebray.11071111: Sigurd I of Norway becomes the first Norwegian king to embark on a crusade to the Holy Land. He fights in Lisbon and on various Mediterranean isles and helps the King of Jerusalem to take Sidon from the Muslims.1108: By the Treaty of Devol, signed in September, Bohemond I of Antioch has to submit to the Byzantine Empire, becoming the vassal of Alexius I.1109: On June 10, Bertrand of Toulouse captures the County of Tripoli (northern Lebanon/western Syria).1109: In the Battle of Nako, Boleslaus III Wrymouth defeats the Pomeranians and re-establishes Polish access to the sea.1109: On August 24, in the Battle of Hundsfeld, Boleslaus III Wrymouth defeats Emperor Henry V of Germany and stops German expansion eastward.Main article: 1110s1111: On April 14, during Henry V's first expedition to Rome, he is crowned Holy Roman Emperor.1113: Paramavishnulok is crowned as King Suryavarman II in Cambodia. He expands the Khmer Empire and builds Angkor Wat during the first half of the century. He establishes diplomatic relations with China.1115: The Georgian army occupies Rustavi in the war with the Muslims.1115: In Java, King Kamesvara of Kadiri ascends to the throne. Janggala ceases to exist and comes under Kadiri domination, highly possible under royal marriage. During his reign, Mpu Dharmaja writes Kakawin Smaradahana, a eulogy for the king which become the inspiration for the Panji cycle tales, which spread across Southeast Asia.[1]1116: The Byzantine army defeats the Turks at Philomelion.1116: Death of doa Jimena Daz, governor of Valencia from 1099 to 1102.c. 1119: The Knights Templar are founded to protect Christian pilgrims in Jerusalem.Main article: 1120sA Black and White Photo of the 12th century Cuenca Cathedral (built from 1182 to 1270) in Cuenca, Spain1120: On January 16, the Council of Nablus, a council of ecclesiastic and secular lords in the crusader Kingdom of Jerusalem, establishes the first written laws for the kingdom.1120: On November 25, William Adelin, the only legitimate son of King Henry I of England, drowns in the White Ship Disaster, leading to a succession crisis which will bring down the Norman monarchy of England.1121: On August 12, in the Battle of Didgori, the greatest military victory in Georgian history, King David the Builder with 45,000 Georgians, 15,000 Kipchak auxiliaries, 500 Alan mercenaries and 100 French Crusaders defeats a much larger Seljuk-led Muslim coalition army.1121: On December 25, St. Norbert and 29 companions make their solemn vows in Premontre, France, establishing the Premonstratensian Order.1122: The Battle of Beroia (Modern-day Stara Zagora, Bulgaria) results in the disappearance of the Pechenegs Turkish tribe as an independent force.1122: On September 23, the Concordat of Worms (Pactum Calixtinum) is drawn up between Emperor Henry V and Pope Calixtus II bringing an end to the first phase of the power struggle between the papacy and the Holy Roman Empire.1122: King David the Builder captures Tbilisi and declares it the capital city of Georgia, ending 400 years of Arab rule.1123: The Jurchen dynasty of China forces Koryo (now Korea) to recognize their suzerainty.1124: In April or May, David I is crowned King of the Scots.1125: On June 11, in the Battle of Azaz, the Crusader states, led by King Baldwin II of Jerusalem, defeat the Seljuk Turks.1125: In November, the Jurchens of the Jin dynasty declare war on the Song dynasty, beginning the JinSong wars.1125: Lothair of Supplinburg, duke of Saxony, is elected Holy Roman Emperor instead of the nearest heir, Frederick of Swabia, beginning the great struggle between Guelphs and Ghibellines.1127: The Northern Song dynasty loses power over northern China to the Jin dynasty.1128: On June 24, the Kingdom of Portugal gains independence from the Kingdom of Len at the Battle of So Mamede; (recognised by Len in 1143).Main article: 1130sThe temple complex of Angkor Wat, built during the reign of Suryavarman II in Cambodia of the Khmer Era.11301180: 50-year drought in what is now the American Southwest.11301138: Papal schism, Pope Innocent II vs. Antipope Anacletus II.1130: On March 26, Sigurd I of Norway dies. A golden era of 95 years comes to an end for Norway as civil wars between the members of Harald Fairhair's family line rage for the remainder of the century.1130: On Christmas Day, Roger II is crowned King of Sicily, the royal title being bestowed on him by Antipope Anacletus II.1132: The Southern Song dynasty establishes China's first permanent standing navy, although China had a long naval history prior. The main admiral's office is at the port of Dinghai.11321183: the Chinese navy increases from a mere 3,000 to 52,000 marine soldiers stationed in 20 different squadrons. During this time, hundreds of treadmill-operated paddle wheel craft are assembled for the navy to fight the Jin dynasty in the north.1135: King Jayabaya of Kadiri ascends to the throne.[2]11351154: The Anarchy takes place, during a period of civil war in England.1136: Suger begins rebuilding the abbey church at St Denis north of Paris, which is regarded as the first major Gothic building.1137: On July 22, the future King Louis VII of France marries Eleanor, the Duchess of Aquitaine.1138: On October 11, the 1138 Aleppo earthquake devastates much of northern Syria.1139: in April, the Second Lateran Council ends the papal schism.1139: On July 5, in the Treaty of Mignano, Pope Innocent II confirms Roger II as King of Sicily, Duke of Apulia, and Prince of Capua and invests him with his titles.1139: On July 25, the Portuguese defeat the Almoravids led by Ali ibn Yusuf in the Battle of Ourique; Prince Afonso Henriques is acclaimed King of Portugal by his soldiers.Main article: 1140sAverroes in a 14th-century painting by Andrea di Bonaiuto11401150: Collapse of the Ancestral Puebloan culture at Chaco Canyon (modern-day New Mexico).1141: The Treaty of Shaoxing ends the conflict between the Jin dynasty and Southern Song dynasty, legally establishing the boundaries of the two countries and forcing the Song dynasty to renounce all claims to its former territories north of the Huai River. The treaty reduces the Southern Song into a quasi-tributary state of the Jurchen Jin dynasty.1143: Manuel I Komnenos is crowned as Byzantine emperor after the death of John II Komnenos.1143: Afonso Henriques is proclaimed King of Portugal by the cortes.1143: The Treaty of Zamora recognizes Portuguese independence from the Kingdom of Len. Portugal also recognizes the suzerainty of the pope.1144: On December 24, Edessa falls to the Atabeg Zengi.11451148: The Second Crusade is launched in response to the fall of the County of Edessa.1147: On October 25, the four-month-long Siege of Lisbon successfully brings the city under definitive Portuguese control, expelling the Moorish overlords.1147: A new Berber dynasty, the Almohads, led by Emir Abd al-Mu'min, takes North Africa from the Almoravides and soon invades the Iberian Peninsula. The Almohads began as a religious movement to rid Islam of impurities.1147: The Wendish Crusade against the Polabian Slavs (or "Wends") in what is now northern and eastern Germany.Main article: 1150s1150: Ramon Berenguer IV, Count of Barcelona marries Petronilla, the Queen of Aragon.1151: The Treaty of Tudiln is signed by Alfonso VII of Len and Raymond Berengar IV, Count of Barcelona, recognizing the Aragonese conquests south of the Jcar and the right to expand in and annex the Kingdom of Murcia.1153: The Treaty of Wallingford, ends the civil war between Empress Matilda and her cousin King Stephen of England fought over the English crown. Stephen acknowledges Matilda's son Henry of Anjou as heir.1153: The First Treaty of Constance is signed between Emperor Frederick I and Pope Eugene III, by the terms of which, the emperor is to prevent any action by Manuel I Comnenus to reestablish the Byzantine Empire on Italian soil and to assist the pope against his enemies in revolt in Rome.1154: the Moroccan-born Muslim geographer Muhammad al-Idrisi publishes his Geography.1154: On December 27, Henry II is crowned King of England at Westminster Abbey.1155: Pope Adrian IV grants overlordship of Ireland to Henry II of England in the bull Laudabiliter.1156: On June 18, the Treaty of Benevento is entered into by Pope Adrian IV and the Norman Kingdom of Sicily. After years of turbulent relations, the popes finally settles down to peace with the Hauteville kings. The kingship of William I is recognized over all Sicily, Apulia, Calabria, Campania, and Capua. The tribute to the pope of 600 schifati agreed upon by Roger II in 1139 at Mignano is affirmed and another 400 shift is added for the new lands.1158: The Treaty of Sahagn ends the war between Castile and Len.Main article: 1160sThe Liuhe Pagoda of Hangzhou, China, 11651161: the Song dynasty Chinese navy, employing gunpowder bombs launched from trebuchets, defeats the enormous Jin dynasty navy in the East China Sea in the Battle of Tangdao and on the Yangtze River in the Battle of Caishi.1161: Kilij Arslan II, Sultan of Rum, makes peace with the Byzantine Empire, recognizing the emperor's primacy.1161: In the siege of Ani, troops from the Kingdom of Georgia take control over the city, only to have it sold for the second time to the Shaddadids, a Kurdish dynasty.1162: Genghis Khan, the founder of the Mongol Empire, is born as Temjin in present-day Mongolia.1163: The Norwegian Law of Succession takes effect.11651182: Tensions and disputes between the Pagan Empire and the Kingdom of Polonnaruwa causes the Sinhalese under Parakramabahu the Great to raid Burma.1168: King Valdemar I of Denmark conquers Arkona on the Island of Rgen, the strongest pagan fortress and temple in northern Europe.1169: Political disputes within the Pandya Empire sparks the decade-long Pandyan Civil War.1169: On May 1, the Norman invasion of Ireland begins. Richard fitzGilbert de Clare ('Strongbow') allies with the exiled Irish chief, Dermot MacMurrough, to help him recover his kingdom of Leinster.Main article: 1170sThe defense of the Carroccio during the battle of Legnano (1176) by Amos Cassioli (18321891)1170: The Treaty of Sahagn is signed by Alfonso VIII of Castile and Alfonso II of Aragon. Based on the terms of the accord, Alfonso VIII agrees to provide Alfonso II with three hostages, to be used as tribute payments owed by Ibn Mardan of Valencia and Murcia.1170: On December 29, Thomas Becket is murdered in Canterbury Cathedral.1171: Saladin deposes the last Fatimid Caliph Al-'id and establishes the Ayyubid dynasty.1171: On November 11, Henry II of England lands in Ireland to assert his claim as Lord of Ireland.1172: The Pandyan city of Madurai is sacked by the Sinhalese army due to an attempt to drive off the rival throne claimant, Kulasekara Pandyan.1173: Sinhalese king Parakramabahu the Great gains a decisive victory by invading the Chola Empire as an ally of the Pandyas in the Pandyan Civil War.1174: On July 12, William I of Scotland is captured by the English in the Battle of Alnwick. He accepts the feudal overlordship of the English crown and pays ceremonial allegiance at York.1175: Hnen Shnin (Genk) founds the Jdo sh (Pure Land) sect of Buddhism.1175: The Treaty of Windsor is signed by King Henry II of England and the High King of Ireland, Ruaidr Ua Conchobair.1176: On May 29, Frederick Barbarossa's forces are defeated in the Battle of Legnano by the Lombard League which results in the emperor's acknowledgment of the pope's sovereignty over the Papal States and Alexander acknowledging the emperor's overlordship of the imperial Church.1176: On September 17, The Battle of Myriokephalon (Myriocephalum; Turkish: Miryakefalon Sava) is fought between the Byzantine Empire and the Seljuk Turks in Phrygia. It is a serious reversal for the Byzantine forces and will be the final, unsuccessful, effort by the Byzantines to recover the interior of Anatolia from the Seljuk Turks.1177: The Treaty or Peace of Venice is signed by the papacy and its allies, and Frederick I, Holy Roman Emperor. The Norman Kingdom of Sicily also participates in negotiations and the treaty thereby determines the political course of all of Italy for the next several years.1178: Chinese writer Zhou Qufei, a Guangzhou customs officer, writes of an island far west in the Indian Ocean (possibly Madagascar), from where people with skin "as black as lacquer" and with frizzy hair were captured and purchased as slaves by Arab merchants.1179: The Treaty of Cazola (Cazorla) is signed by Alfonso II of Aragon and Alfonso VIII of Castile, dividing Andalusia into separate zones of conquest for the two kingdoms, so that the work of the Reconquista would not be stymied by internecine feuding.Main article: 1180s1180: The Portuguese Navy defeats a Muslim fleet off the coast of Cape Espichel.11801185: the Genpei War in Japan.1181: Parakramabahu the Great conducts a large-scale raid on Burma, after a ship transporting a Sinhalese princess to the Khmer Empire is attacked by Burmese naval fleets.1182: Religious reformations of Theravada Buddhism in Pagan Burma under the patronage of Narapatisithu are continued with the end of the Polonnaruwa-Pagan War.1182: Revolt of the people of Constantinople against the Latins, whom they massacre, proclaiming Andronicus I Comnenus as co-emperor.1183: On January 25, the final Peace of Constance between Frederick Barbarossa, the pope and the Lombard towns is signed, confirming the Peace of Venice of 1177.1183: On September 24, Andronicus I Comnenus has his nephew Alexius II Comnenus strangled.1184: On March 24, Queen Tamar, King of Georgia, accedes to the throne as sole ruler after reigning with her father, George III, for six years.1184: Diet of Pentecost organised by Emperor Frederick I in Mainz.1185: The Uprising of Asen and Peter against the Byzantine Empire leads to the restoration of the Bulgarian Empire.1185: Andronicus I Comnenus is deposed and, on September 12, executed as a result of the Norman massacre of the Greeks of Thessalonika.1185: The cathedral school (Katedralskolan) in Lund, Sweden, is founded. The school is the oldest in northern Europe and one of the oldest in all of Europe.1185: Beginning in this year the Kamakura shogunate deprives the emperor of Japan of political power.1186: On January 27, the future Holy Roman Emperor Henry VI marries Constance of Sicily, the heiress to the Sicilian throne.1187: On July 4, in the Battle of Hattin, Saladin defeats the king of Jerusalem.1187: In August, the Swedish royal and commercial center Sigtuna is attacked by raiders from Karelia, Couronia, and/or Estonia.[3]1188: The Riah were introduced into the Habt and south of Tetouan by the Almohad caliph, Abu Yusuf Yaqub al-Mansur, and Jochem and Acem were introduced in Tamesna.[4]1189: On September 3, Richard I is crowned King of England at Westminster.1189: On November 11, William II of Sicily dies and is succeeded by his illegitimate cousin Tancred, Count of Lecce instead of Constance.11891192: The Third Crusade is an attempt by European leaders to wrest the Holy Land from Saladin.Main articles: 1190s and 1

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Electromagnetic Induction: Flux linkage between turns Electrical Conduction: Direct current flow through common winding Energy Transfer: Approximately 85% electromagnetic + 15% conduction \[\begin{aligned} P_{total} &= P_{electromagnetic} + P_{conduction}\\ P_{electromagnetic} &= V_2 \times I_c \times \cos\phi\\ P_{conduction} &= V_2 \times (I_2 - I_c) \times \cos\phi \end{aligned}\] \[\begin{aligned} \text{Transformation ratio: } K &= \dfrac{V_1}{V_2} = \dfrac{N_1}{N_2}\\ \text{For step-down: } V_1 &> V_2 \text{ and } K > 1\\ \text{For step-up: } V_2 &> V_1 \text{ and } K < 1 \end{aligned}\] Voltage transformation follows same law as conventional transformer Current distribution is different due to common winding Typical voltage ratios: 2:1 to 3:1 for economic benefits \[\begin{aligned} I_1 &= \dfrac{I_2}{K} \text{ (from load)}\\ I_c &= I_2 - I_1 = I_2\left(1 - \dfrac{1}{K}\right)\\ I_c &= I_2\left(\dfrac{K-1}{K}\right) \end{aligned}\] \[\begin{aligned} I_2 &= \dfrac{I_1}{K}\\ I_c &= I_1 - I_2 = I_1\left(1 - \dfrac{1}{K}\right)\\ I_c &= I_1\left(\dfrac{K-1}{K}\right) \end{aligned}\] Common winding current \(I_c\) carries the difference between primary and secondary currents. \[\begin{aligned} P_{input} &= V_1 I_1 \cos\phi_1\\ P_{output} &= V_2 I_2 \cos\phi_2\\ P_{electromagnetic} &= V_2 I_c \cos\phi\\ P_{conduction} &= V_2 (I_2 - I_c) \cos\phi \end{aligned}\] Copper Saving Ratio: \[\text{Copper Saving} = \left(1 - \dfrac{1}{K}\right) \times 100\%\] Higher efficiency than conventional transformers (95-98%) Reduced copper losses in common winding section Same iron losses as conventional transformers \[\eta = \dfrac{P_{output}}{P_{input}} = \dfrac{V_2 I_2 \cos\phi_2}{V_1 I_1 \cos\phi_1}\] Auto-transformer efficiency is higher because: Reduced \(I^2R\) losses in common winding Less copper required for same power rating Higher efficiency \((2-3\%)\) better than conventional) Reduced size and cost due to copper saving Better voltage regulation (lower impedance) Lower losses in common winding Improved power factor at light loads Cost reduction proportional to \((1 - 1/K)\) Weight reduction due to less copper Smaller size for same power rating No electrical isolation - major limitation Higher short-circuit current due to direct connection Limited voltage ratio applications (economical up to \(3:1\)) Safety concerns - common neutral point Harmonic transfer between primary and secondary Auto-transformers are NOT used when: Electrical isolation is required High voltage ratios are needed (\(>3:1\)) Safety is a primary concern A 10 kVA, 400V/200V auto-transformer is connected as step-down. Load current is 50 A at 0.8 pf lagging. Calculate: Transformation ratio Primary current Common winding current for same power transferred electromagnetically and conductively \[\begin{aligned} K &= \dfrac{400}{200} = 2\\ I_1 &= \dfrac{I_2}{K} = \dfrac{50}{2} = 25 \text{ A}\\ I_c &= I_2 - I_1 = 50 - 25 = 25 \text{ A}\\ P_{em} &= 200 \times 25 \times 0.8 = 4000 \text{ W}\\ P_{cond} &= 200 \times 25 \times 0.8 = 4000 \text{ W} \end{aligned}\] Calculate the copper saving in an auto-transformer with transformation ratio \(2.5:1\) compared to a conventional transformer of same rating. \[\begin{aligned} K &= 2.5\\ \text{Copper Saving} &= \left(1 - \dfrac{1}{K}\right) \times 100\%\\ &= \left(1 - \dfrac{1}{2.5}\right) \times 100\%\\ &= \left(1 - 0.4\right) \times 100\%\\ &= 0.6 \times 100\% = 60\% \end{aligned}\] Higher the transformation ratio, greater the copper saving (up to practical limits). \[\begin{aligned} K &= \dfrac{V_1}{V_2} = \dfrac{N_1}{N_2} \text{ (Transformation ratio)}\\ I_c &= I_2\left(1 - \dfrac{1}{K}\right) \text{ (Common winding current)}\\ \text{Copper Saving} &= \left(1 - \dfrac{1}{K}\right) \times 100\%\\ P_{em} &= V_2 I_c \cos\phi \text{ (Electromagnetic power)}\\ P_{cond} &= V_2(I_2 - I_c)\cos\phi \text{ (Conduction power)}\\ \eta &= \dfrac{P_{out}}{P_{in}} \text{ (Efficiency)} \end{aligned}\] Auto-transformer = Higher efficiency + No isolation Copper saving increases with transformation ratio Suitable for voltage ratios up to \(3:1\) Power Systems: Voltage regulation Transmission interconnection Distribution voltage control Reactive power compensation Industrial Applications: Motor starting (reduced current) Voltage stabilizers Laboratory equipment Lighting control Motor starting applications (current reduction) Voltage regulation in power systems Efficiency calculations and comparisons Economic analysis (copper saving) Definition: Single winding transformer with electrical connection Key Feature: No electrical isolation between primary and secondary Efficiency: Higher than conventional transformers (95-98%) Copper Saving: \((1 - 1/K) \times 100\%\) Applications: Limited by lack of isolation Voltage Ratio: Economical up to 3:1 Can you calculate transformation ratio, currents, and power distribution? Do you know when NOT to use auto-transformers? Can you compare efficiency with conventional transformers? Share copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Download the Testbook APP & Get Pass Pro Max FREE for 7 Days10,000+ Study NotesRealtime Doubt Support71000+ Mock TestsRankers Test Series+ more benefitsDownload App Now An Auto Transformer refers to a transformer that features a single winding wound around a laminated core. An autotransformer is like a two-winding transformer however contrast in the manner the primary winding and secondary winding are interrelated. A piece of the winding is common to both the primary side and secondary sides. In this article, we will be going through Auto Transformer, First we will start our Article with What is an AutoTransformer, next, we will go through the construction and Working of an Autotransformer, Then we will go through the Autotransformer Theory and Copper Savings in an Auto Transformer, At last, we will conclude our Article with Advantages, Disadvantages, Applications and Some FAQs. What is an AutoTransformer?An autotransformer is an electrical transformer characterized by having a solitary winding. The "auto" prefix refers to the single coil acting alone (In Greek "self") - not to any programmed instrument. An auto transformer is like a two-winding transformer yet changes in the manner the primary winding and secondary winding of the transformer are interrelated. An autotransformer has a single consistent winding with a tap point between the primary winding and secondary windings. The autotransformer has a clear advantage because the tap point can be changed to get the voltage you want at the output. The fact that the secondary winding is not electrically isolated from the primary is the autotransformer's primary drawback. On load condition, a piece of the load current is applied directly from the supply, and the remaining part is acquired by transformer action. An Autotransformer functions as a voltage regulator. Auto Transformer Construction and Working of AutoTransformerIn a conventional transformer, the primary and the secondary windings are electrically insulated from one another but connected magnetically as shown in the figure below. In an auto Transformer, the primary and secondary windings are linked both magnetically and electrically. Ordinary Transformer Auto transformers can be categorized into two types based on their construction. In the first type, a continuous winding is employed with taps strategically positioned to achieve the desired secondary voltage. Conversely, the second type features at least two distinct coils that are electrically interconnected to create a seamless winding. The schematic representation of the auto transformer construction is depicted in the figure below. Auto Transformer The primary winding AB from which a tapping at C is taken, that CB goes about as an optional winding. The supply voltage is applied across the AB, and the load is connected across the CB. The tapping could be constant or fluctuating. When AC voltage V1 is applied across AB, an alternating flux is set up in the core, thus, an emf E1 is induced in the winding AB. A part of this induced emf is taken in the secondary side circuit. Let, V1 is Primary applied voltage V2 is Secondary voltage across the load I1 is Primary current I2 is load current N1 is number of turns among A and B N2 is number of turns among C and B Neglecting no-load current, leakage reactance and losses, V1 = E1 and V2 = E2 Therefore, the transformation ratio: K = V2 / V1 = N2 / N1 = I1 / I2 As the secondary ampere-turns are opposite to primary ampere-turns, so the current I2 is in phase opposition to I1. The secondary voltage is less than the primary. Accordingly current I2 is more than the current I1. As a result, the current that flows through section BC is (I2I1). The ampere-turns because of section BC = current x turns Ampere-turns because of section BC = (I1 - I2) N2 = (I1 /K - I1) x N1 K = I1 N1 (1 - K) - - - (Equation 1) Ampere-goes because of section AC =I1 (N1 - N2) = I1N1 (1 - N2/N1) = I1N1(1 - K) - - - (Equation 2) Auto-transformer-Equation (1) and (2) shows that the ampere-turns because of section BC and AC balance each other which is characteristics for the transformer action. Case 1 : Autotransformer on No-LoadThe connection diagram of a unloaded autotransformer (step-down and step-up) is shown in the figure. In this, the winding 'AB' is called primary winding having N1 turns and the winding 'bc' is called secondary winding having N2 turns. AutoTransformer on No-Load Here it can be noticed that the primary and secondary windings are connected magnetically as well as electrically. As a result, the primary winding's power is transferred magnetically and conductively to the secondary winding. Case 2: Autotransformer on Load A load is connected to be loaded if it is connected to an autotransformer's secondary. The figure shows the circuit diagram of a autotransformer (step-down and step-up) Autotransformer on Load In which the current I1 is the primary input current and the current I2 is the secondary output current or load current. The current in like common portion of the primary and secondary windings is the difference of the currents I1 and I2,whether the autotransformer is stepdown or step up. For the step-down autotransformer the ongoing I2 > I1, thus the current flowing in the common portion is Current in common portion = I2 - I1 For the step-up autotransformer the current I2 < I1, thus the current in the common portion is Current in common portion = I1 - I2 Copper Savings in an Auto Transformer Now, we'll talk about the how much copper is saved in an auto transformer when compared to a standard two-winding transformer. Any winding's copper weight is known to be depends by its length and cross-sectional area. Again, the length of a conductor in a winding is inversely proportional to the number of turns it has, and the cross-sectional area varies depending on the rated current. So weight of copper in winding is directly proportional to result of number of turns and rated current of the winding. Hence, the weight of copper in section AC is directly proportional to, (N1 - N2) I also, similarly, weight of copper in the section BC proportional to, N2(I2- I1) Consequently, total weight of copper in the winding of auto transformer proportional to, (N1 - N2) I1 = N2 (I2 - I1) N1 I1 - N2 I1 + N2 I2 - N2 I1 N1 I1 + N2 I2 - 2 N2 I1 2N1 I1 - 2N2 I1 2(N1 I1 - N2 I1) Similarly, it can be demonstrated that the weight of copper in a two-winding transformer is directly proportional to, N1 I1 + N2 I2 2N1 I1 N1 I1 + N2 I2 2N1 I1 (Since, in a transformer N1 I1 = N2 I2) Assume that, Wa and Wtw are weight of copper in auto transformer and two winding transformer separately, Hence, Wa / Wtw = 2 (N1 I1 - N2 I1) / 2(N1 I1) = N1 I1 - N2 I1 / N1I1 = (1 - N2 I1 / N1 I1) = (1 - N2/ N1) = 1-K Wa = Wtw (1 - k) Wa = Wtw - kWtw Saving of copper in auto transformer compared with two winding transformer, W tw - Wa = kw tw Auto transformer employ's just single winding per phases work as against two particularly separate windings in a conventional transformer. Advantages of AutotransformerThe Following are Advantages of autoTransformer An autotransformer has smaller core and copper losses and thus higher efficiency when compared with a conventional 2-winding transformer.Autotransformer requires less conductor material when contrasted with the 2-winding transformer.Reduced voltage drops in resistance and leakage reactance result in improved voltage regulation.It has more smaller size and cheaper in cost than a 2-winding transformer.It requires more modest excitation current.Variable voltages can be produced by an autotransformer. Disadvantages of AutotransformerThe Following are Disadvantages of autoTransformer There is an direct connection between the primary and secondary sides. The load on the secondary side would receive the full primary voltage in the event of an open circuit in the common portion bc of the windings. This might harm the hardware connected with the secondary side.An autotransformer has reduced inside impedance when compared with a 2-winding transformer which brings about a larger short circuit current.The autotransformer isn't electrically isolated, in this manner can't be used to electrically disconnect two circuitsApplications of AutotransformerThe Following are Applications of autoTransformer Power systems with varying voltage levels can be connected to one another through the use of autotransformers.The autotransformers with recordings are utilized for turning over enlistment engines and coordinated engines.When a continuous variable voltage over a wide range is required, autotransformers are used as variac (variable AC).It is used as a starter to surrender to 50 to 60% of full voltage to the stator of a squirrel confine enlistment engine during turning over.Conclusion In conclusion, autotransformers stand apart as efficient and cost-effective electrical devices with flexible applications. Their single-winding design, serving both as primary and secondary coils, empowers a more compact and economical construction contrasted with ordinary transformers. Autotransformers are especially advantageous when space is a premium, and cost contemplations are crucial. Autotransformers are suitable for applications requiring precise voltage regulation due to their ability to adjust output voltage through tap variations. This flexibility renders them important in power conveyance, engine control, and voltage change situations. Be that as it may, it's essential to recognize their constraint in lacking total electrical separation among essential and optional sides, which might be a worry in applications focusing on segregation for safety or hardware protection. Autotransformers are adept at taking care of dynamic load requirements, on account of tap-changing systems in certain models. Cautious thought of working circumstances is fundamental to improve their productivity. Despite their limitations, the general advantages of proficiency, flexibility, and cost-viability go with autotransformers a favored decision in different enterprises, adding to smoothed out electrical systems and conservative answers for voltage change. In this topic, you study Auto transformer Theory, Diagram, Advantages & Applications. An auto transformer is a transformer having only one winding wound on a laminated magnetic core, the part of this winding being common to both the primary and secondary circuits. As an ordinary two winding transformer, it can be used as a step-down or a step-up transformer as illustrated in Figs. 1 (a) and (b) respectively.(a)(b)Fig. 1: (a) Step-down auto transformer, (b) Step-up auto transformerIn Fig. 1 (a), the winding AC forms the primary and its portion BC forms the secondary On the other hand, in Fig. 1 (b), the winding AC forms the secondary and its portion BC forms the primary. The performance of the auto transformer is governed by the same fundamental considerations which we have already discussed for the two winding transformers. Hence, in the case of an auto transformer also, neglecting the losses, the leakage reactance and the magnetizing current, we have\[\frac{{{\text{V}}_{\text{2}}}}{{{\text{V}}_{\text{1}}}}=\frac{{{\text{I}}_{\text{1}}}}{{{\text{I}}_{\text{2}}}}=\frac{{{\text{N}}_{\text{2}}}}{{{\text{N}}_{\text{1}}}}=\text{K}\](With usual notations)Saving of CopperFor the same capacity (i.e. output) and voltage ratio, the auto transformer requires less copper than a conventional two winding transformer. This can beeasily verified as follows. For any winding,Cross-section of conductor Current carried, ITotal length of conductor Number of turns, NHence,Volume of copper or the weight of copper NINow, let us use this relationship to compare the requirement of copper in the case of anordinary two winding transformer and the auto transformer performing the same duty andhaving the same capacity and voltage ratio.Two winding TransformerWeight of copper for primary winding N1I1Weight of copper for secondary winding N2I2 Total weight of copper (N1I1 + N2I2) (1)Step-down Auto transformerCurrent distribution in the winding is shown in Fig. 1 (a). Section AB having (N1 N2) turns carries a current I1. Since the currents, I1 and I2 are practically in phase opposition and I2 is greater than I1, the section BC having N2 turns carries the resultant current (I2 I1). Hence,Weight of copper for section AB (N1 N2) I1Weight of copper for section BC N2(I2 I1)Total weight of copper (N1 N2) I1 + N2(I2 I1) ..(2)Therefore from the equations (1) and (2), we have\[\frac{\text{Weight of copper in step-down auto-transformer}}{\text{Weight of copper in two-winding transformer}}\]\[=\frac{({{\text{N}}_{1}}-{{\text{N}}_{2}}){{\text{I}}_{1}}+{{\text{N}}_{2}}({{\text{I}}_{2}}-{{\text{I}}_{1}})}{{{\text{N}}_{1}}{{\text{I}}_{1}}+{{\text{N}}_{2}}{{\text{I}}_{2}}}\]\[=\frac{{{\text{N}}_{1}}{{\text{I}}_{1}}+{{\text{N}}_{2}}{{\text{I}}_{2}}-2{{\text{N}}_{2}}{{\text{I}}_{1}}}{{{\text{N}}_{1}}{{\text{I}}_{1}}+{{\text{N}}_{2}}{{\text{I}}_{2}}}\]\[=1-\frac{2{{\text{N}}_{\text{2}}}{{\text{I}}_{1}}}{{{\text{N}}_{1}}{{\text{I}}_{1}}+{{\text{N}}_{2}}{{\text{I}}_{2}}}\]\[=1-\frac{2}{\left({{\text{N}}_{1}}/{{\text{N}}_{2}} \right)+\left({{\text{I}}_{2}}/{{\text{I}}_{1}} \right)}\]Since,\[\frac{{{\text{N}}_{1}}{{\text{I}}_{1}}}{{{\text{N}}_{2}}{{\text{I}}_{2}}}=\frac{{{\text{I}}_{1}}}{{{\text{I}}_{2}}}=\frac{1}{\text{K}}\]Thus,\[=1-\text{K}\]Hence,Saving of copper in step-down auto-transformer= (Weight of copper in two-winding transformer) (Weight of copper in step-down auto-transformer)= (Weight of copper in two-winding transformer) (1 K) (Weight of copper in two-winding transformer)= K (Weight of copper in two-winding transformer)..(3)Step-up Auto transformerCurrent distribution in the winding is shown in Fig. 1 (b). Section AB having (N2 N1) turns carries a current I2. Since the currents, I1 and I2 are practically in phase opposition I1 and I2 being greater than , the section BC having N1turns carries the resultant current (I1 I2). Hence,Weight of copper for section AB (N2 N1) I2Weight of copper for section BC N1(I1 I2)Total weight of copper (N2 N1) I2+ N1(I1 I2) ..(4)Therefore from the equations (1) and (4), we have\[\frac{\text{Weight of copper in step-up auto-transformer}}{\text{Weight of copper in two-winding transformer}}\]\[=\frac{({{\text{N}}_{2}}-{{\text{N}}_{1}}){{\text{I}}_{2}}+{{\text{N}}_{1}}({{\text{I}}_{1}}-{{\text{I}}_{2}})}{{{\text{N}}_{2}}{{\text{I}}_{2}}+{{\text{N}}_{1}}{{\text{I}}_{1}}}\]\[=\frac{{{\text{N}}_{2}}{{\text{I}}_{2}}+{{\text{N}}_{1}}{{\text{I}}_{1}}-2{{\text{N}}_{1}}{{\text{I}}_{2}}}{{{\text{N}}_{2}}{{\text{I}}_{2}}+{{\text{N}}_{1}}{{\text{I}}_{1}}}\]\[=1-\frac{2{{\text{N}}_{1}}{{\text{I}}_{2}}}{{{\text{N}}_{2}}{{\text{I}}_{2}}+{{\text{N}}_{1}}{{\text{I}}_{1}}}\]\[=1-\frac{2}{\left({{\text{I}}_{1}}/{{\text{I}}_{2}} \right)+\left({{\text{N}}_{2}}/{{\text{N}}_{1}} \right)}\]Since,\[\frac{{{\text{I}}_{1}}}{{{\text{I}}_{2}}}=\frac{{{\text{N}}_{2}}}{{{\text{N}}_{1}}}=\text{K}\]Thus,\[=1-\frac{1}{\text{K}}\]Hence,Saving of copper in step-up auto-transformer= (1/K) Weight of copper in two-winding transformer ..(5)From the equations (3) and (5), it is obvious that the nearer the ratio of the transformation is to unity, the greater is the saving of copper.Advantages of Auto transformerWeight of copper required in an auto transformer is always less than that of the conventional two winding transformer and hence it is comparatively cheaper. The saving of copper is increased as the transformation ratio approaches unity.The resistance and leakage reactance of an auto transformer being less than the corresponding two winding transformer, its regulation is better.I2R losses being less, the efficiency of an auto transformer is higher than that of the two winding transformer.Disadvantages of Auto transformerIn the case of an auto transformer, there is always a risk of seriouselectric shock particularly when it is used in the high voltage circuit. This is because the lowvoltage and high voltage sides are not electrically separate.Applications of Auto transformerFor stating squirrel-cage induction motors and synchronous motors.For interconnecting ac systems having roughly the same operating voltage.As boosters to raise the voltage in ac feeders.As furnace transformers for getting suitable supply voltage.As variacs for getting continuously variable ac supply voltage. This is the most common application of the auto transformers. We know that ordinary rheostat can be used as a potential divider for getting continuously variable ac voltage. But it is useful only for stepping down the voltage. On the other hand, the auto transformer even though costlier has the distinct advantage that it can step-up as well as step-down the voltage and has negligible losses. Fig. 2 (a) shows the constructional details of a single phase variac and Fig. 2 (b) the necessary connection diagram.(a)(b)Fig. 2: Single phase variacIt has its winding wound on a toroidal core. Input voltage (V1) is applied between the terminals A and B. A continuously variable output voltage (V2) from zero to about 120Single Phase TransformerIn this topic, you study Single Phase Transformer. The transformers are designed to operate eitherDry Type TransformerIn this topic, you study Dry Type Transformer. The transformers using air as coolant are What is Autotransformer:Autotransformer is a special type of transformer that consists of a single winding. This winding is used for both primary & secondary (High voltage & low voltage) sides. It is widely used for its variable output voltage function, lower cost & small size.In a conventional two winding transformer, there are two separate windings for high & low voltage side. The connection between these two windings is purely magnetic (mutual induction). It implies that there is electrical isolation between both windings.On the other hand, Autotransformer utilizes a single winding as primary & secondary at the same time. Due to this, the input & output are connected electrically & also magnetically through self-induction. The electrical connection does include a hazard of removing the isolation between windings but this single winding provides many advantages that are discussed in this article below. Related Post:Types of Transformers and Their Applications A standard autotransformer, as shown in the figure below, has one single winding around a laminated core. This single winding is used for both primary & secondary circuit.Their winding consists of at least three terminals i.e. A, B & C as shown in the figure. The terminals A & B are fixed terminals while the terminal C is a variable tap point. The AC supply is applied to fixed terminals A & B while the load is connected between variable Tap point C & B.The autotransformer can have multiple tap points to provide a variable output voltage. Each of these tap points is designed to provide a different turn ratio of the transformer, hence varying the output voltage.The figure above shows multiple tap points i.e. C1, C2, C3. While the other two terminals A & B is fixed. Apart from the electrical connection between the primary & secondary, there is an energy flow through induction. That is because of the varying AC current in the winding generates a varying magnetic flux, which induces an EMF in the winding, also known as self-induction. So the output of autotransformer is a combination of energy transformation & electrical conduction, thus it has more efficiency than a conventional two winding transformer but at the cost of no electrical isolation. The winding from point A to B acts as primary winding while the common winding between C & B acts as the secondary winding. Assume the number of turns in the primary winding is N1 & the

Energy Losses in a TransformerAdvantages of Autotransformer:The most prominent feature of an autotransformer is that it saves copper. The amount of copper used in an autotransformer is less than a two winding transformer of the same ratings. Thus it reduces the capital required for its construction.The single winding used in the autotransformer significantly reduces its size & weight.Having small size & weight of the autotransformer, it enables it to have a high VA rating than an ordinary two winding transformer for the same amount of material.The voltage regulation is much better than the two-winding transformer because of the elimination of the losses in the second winding.Due to the electrical conduction, magnetic induction & reduction in the losses due to the second winding, the efficiency of the autotransformer is higher than the two-winding transformer.Related Post:EMF Equation Of a TransformerDisadvantages of Auto transformer:There is no electrical isolation between the windings. So grounding the primary of an autotransformer wont eliminate the risk of an electrical shock as both windings are electrically connected. The circuit will still complete through the ground.Due to the electrical isolation present between the winding, two winding transformer blocks the transfer of harmonics between the load & supply, while autotransformer actually cant.Because of the low leakage flux between primary & secondary, the impedance of the autotransformer is low. Thus it may result in large fault currents in the secondary.Related Post:Maintenance of Transformer Power Transformers Maintenance, Diagnostic & MonitoringApplications of Autotransformer:They are used for the compensation of the voltage drop in the distribution transformers.For starting induction & synchronous motors, several methods are used. One of the methods is using an autotransformer.A variable autotransformer also known as Variac, which has continuous variable output voltage is used in the laboratories.A break in the common winding of the autotransformer will result in full input voltage at the load.Related Posts: Share copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. The article explains the working principle, types, and electrical characteristics of autotransformer, highlighting their advantages such as cost-effectiveness and efficiency, as well as disadvantages like lack of electrical isolation. It also covers common applications and provides an example illustrating their capacity compared to conventional transformers. Autotransformer Definition The autotransformer has a single winding on an iron core. One of the coil terminals is common to both input and output, and the other output terminal is movable so that it can make contact with any turn on the winding.Step-Up/ Step-Down Autotransformer An autotransformer can be used as a step-up or a step-down transformer. As a step-up, it is often referred to as a boost, and as a step-down, it is called a buck connection. Figure 1 shows the schematic representation of buck connection while figure 2 shows the boost connection.Autotransformer OperationThe autotransformer serves a function similar to that of the ordinary transformer to raise or lower voltage. It consists of a single continuous winding with a tap brought out at some intermediate point as shown in Fig.1. Because the primary and secondary windings of the autotransformer are physically connected, the supply and output voltage are not insulated from each other.Figure.1: Autotransformer Circuit Diagram When a voltage V1 is applied to the primary of the autotransformer, the induced voltages are related by\[\begin{matrix} \frac{{{E}_{1}}}{{{E}_{2}}}=\frac{{{E}_{ac}}}{{{E}_{bc}}}=\frac{{{N}_{1}}}{{{N}_{2}}}=a & (} & \left(1 \right) \\\end{matrix}\]Neglecting voltage drops in the windings\[\begin{matrix} \frac{{{V}_{1}}}{{{V}_{2}}}=a & (} & \left(2 \right) \\\end{matrix}\]When a load is connected to the secondary of the autotransformer, a current I2 flows in the direction shown in Fig.1. By Kirchhoffs current law,\[\begin{matrix} {{I}_{2}}={{I}_{1}}+\text{ }{{I}_{3}} & (} & \left(3 \right) \\\end{matrix}\] As in the ordinary transformer, the primary and secondary ampere-turns balance each other, except for the small current required for core magnetization:\[\begin{matrix} {{N}_{1}}{{I}_{1}}={{N}_{2}}{{I}_{2}} & (} & (4) \\\end{matrix}\]Equation 4 may also be written as\[\begin{matrix} \frac{{{I}_{2}}}{{{I}_{1}}}=\frac{{{N}_{1}}}{{{N}_{2}}}=a & (} & \left(5 \right) \\\end{matrix}\]Substituting Equation (5) into Equation (3), the ratio of the winding current is found as\[\begin{matrix} \frac{{{I}_{3}}}{{{I}_{1}}}=a-1 & (} & \left(6 \right) \\\end{matrix}\]In an autotransformer, the total power transmitted from the primary to the secondary does not actually pass through the whole winding. This means that a greater amount of power can be transferred without exceeding the current rating of the windings of the transformer.\[\begin{matrix} {{S}_{1}}=\text{ }{{V}_{1}}{{I}_{1}} & (} & \left(7 \right) \\\end{matrix}\]Similarly, the output apparent power is given by \[\begin{matrix} {{S}_{2}}=\text{ }{{V}_{2}}{{I}_{2}} & (} & \left(8 \right) \\\end{matrix}\]However, the apparent power in the transformer windings is\[\begin{matrix} {{S}_{w}}=\text{ }{{V}_{2}}{{I}_{3}}=({{V}_{1}}-{{V}_{2}}){{I}_{2}}=\text{ }{{S}_{ind}} & (} & \left(9 \right) \\\end{matrix}\]This power is the component of the power transferred by transformer action or by electromagnetic induction. The difference (S2 Sw) between the output apparent power and the apparent power in the windings is the component of the output transferred by electrical conduction. This is equal to \[\begin{matrix} {{S}_{cond}}=\text{ }{{V}_{2}}{{I}_{2}}-\text{ }{{V}_{2}}{{I}_{3}}=\text{ }{{V}_{2}}{{I}_{1~~~~~~~~~~~~~~~~~~~~}} & (} & \left(10 \right) \\\end{matrix}\]Advantages of an AutotransformerNote that if the turns ratio of the transformer is large, the power rating as an autotransformer will be much larger than the rating as a conventional transformer. In a conventional transformer, all of the power is transformed, whereas in an autotransformer, most of the power is conducted at an elevated potential. Asa result, an autotransformer is much smaller than a conventional transformer of the same rating.Other advantages of an autotransformer over a two winding transformer are:CheaperMore efficient, because losses stay the same while the rating goes up compared to a conventional transformerLower exciting currentBetter voltage regulationDisadvantages of an AutotransformerSome of the disadvantages of an autotransformer are:Larger short-circuit currentNo isolation exists between the primary and secondary windingsOnly useful for moderately smaller voltage changesApplications of AutotransformerPractical applications/uses of autotransformers include:They are generally used to connect transmission lines of slightly different voltages (e.g., 115 kV and 138 kV or 138 kV and 161 kV)They are employed to compensate for voltage drops on long feeder circuits where it is important that each load device receives the same voltage (e.g., on airfield lighting circuits to ensure uniform lamp intensity)They offer variable voltage control in the laboratory setup: as we move the sliding contact, virtually all of the coil can become the series coil. Therefore, the entire coil must be sized for maximum current.They are used to adjust the transformer output voltage in order to keep the system voltage constant with varying load.Autotransformer ExampleA single-phase, 10-kVA, 440/110-V, two- winding transformer is connected as an autotransformer to supply a load at 550 V from a 440 V supply as shown below. Calculate the following.kVA rating as an autotransformerapparent power transferred by conductionapparent power transferred by electromagnetic inductionSolution The single phase, a two-winding transformer is reconnected as an autotransformer as shown in Fig.2. The current ratings of the windings are given byFigure 2: Autotransformer Example \[\begin{array}{*{35}{l}} {{I}_{ab}}=10,000/110\text{ }=\text{ }90.9\text{ }A \\ {{I}_{ab}}=10,000/440\text{ }=\text{ }22.7\text{ }A \\\end{array}\]At full or rated load, the primary and secondary terminal currents are\[\begin{array}{*{35}{l}} {{I}_{2}}=\text{ }90.9\text{ }A \\ {{I}_{1~}}={{I}_{2}}+{{I}_{3}}~=90.9+22.7~=~113.6\text{ }A \\\end{array}\]Therefore, the kVA rating of the autotransformer is\[\begin{array}{*{35}{l}} kV{{A}_{1}}~=\left(440 \right)\left(113.6 \right)/1000~=50\text{ }kVA \\ kV{{A}_{2}}~=\left(550 \right)\left(90.9 \right)/1000~=50\text{ }kVA \\\end{array}\]Note that this transformer, whose rating as an ordinary two-winding transformer is only 10 kVA, is capable of handling 50 kVA as an autotransformer. However, not all of the 50 kVA is transformed by electromagnetic induction. The apparent power transformed by induction is\[{{S}_{ind}}={{V}_{1}}{{I}_{3}}=\left(440 \right)\left(22.7 \right)VA=10kVA\]The apparent power transformed by conduction is\[{{S}_{cond}}={{V}_{1}}{{I}_{2}}=\left(440 \right)\left(90.9 \right)VA=40\text{ }kVA\]Key Takeaways of AutotransformerAutotransformer operation involves a single winding with multiple taps, providing voltage transformation and regulation. It finds applications in voltage regulation, motor starting, and power supply circuits, offering advantages such as compact size and cost-effectiveness, but it has the disadvantage of limited isolation between the primary and secondary windings.Frequently Asked Questions (FAQs) about AutotransformerWhat is an autotransformer and how does it work? An autotransformer is a type of transformer that uses a single winding with multiple taps to provide voltage transformation. It operates on the principle of a common portion of the winding serving as both the primary and secondary coil.What are the applications of autotransformers?Autotransformers find applications in various industries, including power transmission and distribution, voltage regulation, motor control, and audio systems. They are commonly used to step up or step-down voltage levels.What are the advantages of using autotransformers? Autotransformers offer advantages such as compact size, lower cost compared to traditional transformers, and higher efficiency due to the shared winding design. They also provide continuous voltage adjustment capabilities.What are the disadvantages of autotransformers? The main disadvantage of autotransformers is the lack of electrical isolation between the primary and secondary windings. This limits their use in applications where isolation is critical, such as in sensitive electronic circuits or where safety considerations are paramount.Can autotransformers handle high-power applications?Yes, autotransformers can handle high-power applications. However, careful design and consideration of safety measures are essential to ensure proper voltage regulation and protection against overcurrent or fault conditions. What is Autotransformer:Autotransformer is a special type of transformer that consists of a single winding. This winding is used for both primary & secondary (High voltage & low voltage) sides. It is widely used for its variable output voltage function, lower cost & small size.In a conventional two winding transformer, there are two separate windings for high & low voltage side. The connection between these two windings is purely magnetic (mutual induction). It implies that there is electrical isolation between both windings.On the other hand, Autotransformer utilizes a single winding as primary & secondary at the same time. Due to this, the input & output are connected electrically & also magnetically through self-induction. The electrical connection does include a hazard of removing the isolation between windings but this single winding provides many advantages that are discussed in this article below. Related Post:Types of Transformers and Their Applications A standard autotransformer, as shown in the figure below, has one single winding around a laminated core. This single winding is used for both primary & secondary circuit.Their winding consists of at least three terminals i.e. A, B & C as shown in the figure. The terminals A & B are fixed terminals while the terminal C is a variable tap point. The AC supply is applied to fixed terminals A & B while the load is connected between variable Tap point C & B.The autotransformer can have multiple tap points to provide a variable output voltage. Each of these tap points is designed to provide a different turn ratio of the transformer, hence varying the output voltage.The figure above shows multiple tap points i.e. C1, C2, C3. While the other two terminals A & B is fixed. Apart from the electrical connection between the primary & secondary, there is an energy flow through induction. That is because of the varying AC current in the winding generates a varying magnetic flux, which induces an EMF in the winding, also known as self-induction. So the output of autotransformer is a combination of energy transformation & electrical conduction, thus it has more efficiency than a conventional two winding transformer but at the cost of no electrical isolation. The winding from point A to B acts as primary winding while the common winding between C & B acts as the secondary winding. Assume the number of turns in the primary winding is N1 & the number of turns in the secondary winding is N2. So the transformer turn ratio is given by;Turn ratio, k = N2 /N1This turn ratio may vary depending on the variable tap point which can increase or decrease the number of turns in the secondary N2.Assume the transformer has no losses & the voltage supplied to the primary is V1 & the secondary voltage across to the load is V2 then;V2 / V1 = N2 / N1 = kV2 = V1 kV2 = V1 (N2 / N1) By varying the tap point C in the winding, we can change the turn ratio k. This will result in a variable secondary voltage. So the output voltage of an autotransformer can be varied by moving the tap point.Related post:Why Transformer Rated In kVA, Not in KW?Types of Autotransformers:Based on increasing & decreasing the voltage, autotransformer is divided into two types i.e. Step up transformer & step down transformer. Just like two winding transformers, a single autotransformer can be used in both configurations.Step Up AutotransformerSuch kind of autotransformers output voltage exceeds its input voltage & vice versa for its current.For performing the step-up function, the AC supply is connected to the variable tap point C & B. while the load is connected to the terminal A & C as shown in the figure down below.In such configuration, the number of turns in the primary winding N1 (input winding) which between C & B, is less than the number of turns in the secondary winding N2.So the turn ratio (N2 / N1) becomes greater than one, which is the condition for a step up transformer. Related Posts:Uses and Application of TransformerOpen Delta Connections of TransformersStep Down AutotransformerIn step down autotransformer, the output voltage is less than the input voltage & the output current is greater than the input current.In order to perform step down function, the connections are reversed to the step up configuration. The AC supply is connected to the fixed terminals (A & B) of the autotransformer, while the load is connected between terminals C & B.The number of turns in the primary winding N1 between point A & B exceeds the number of turns in secondary winding N2. Hence the turn ratio becomes less than 1, which is the condition for step down transformer.Related Post:Difference between Power and Distribution Transformers?Copper Saving In Autotransformer:The most prominent feature of the autotransformer is its copper saving compared to a conventional two winding transformer.Copper weight depends on its length and its cross-sectional area. However, the length of copper in a transformer corresponds to the number of turns and the cross-sectional area corresponds to its current rating. Thus the copper weight in a transformer is; Weight of copper = N x IWhere N is the number of turns and I is the current flowing through it.Due to two different currents in the winding of the autotransformer, the winding in divided into two sections i.e. AC & CB.The copper weight for section AC is;WAC I1 (N1-N2)I1 is the current flowing through it & (N1-N2) is the number of turns between A & C point.The copper weight for section CB; WCB (I2 I1) N2 N2 is the number of turns between point C & B. The current (I2 I1) however is because the Load current I2 is opposite in phase to the current I1. As we know that the output voltage decreases because of the lower secondary turns, the output current I2 exceed the primary current I1. So the results of both current become (I2 I1).Now the total copper weight of the winding of autotransformer, Wa is;Wa (WAB + WBC)Wa I1 (N1 N2) + (I2 I1) N2Wa I1N1 I1N2 + I2 N2 I1N2Wa I1N1+ I2N2 2 I1N2 Now lets find the copper weight of a conventional two winding transformer;Copper weight of primary winding;Wp I1N1Copper weight of secondary winding;Ws I2N2The total copper weight of two-winding transformer;Wtw Wp + WsWtw I1N1 + I2N2Now, the copper weight ratio of autotransformer to the two-winding transformer;Dividing by I1N1Now the difference between the copper weight of auto & two-winding transformer is;So the copper saving in autotransformer depends on its turn ratio. As the turn ratio of autotransformer remains less than unity, the copper saving increases when the turn ratio reaches near unity.Related Post:Power Transformer Protection & FaultsPercentage Copper SavingThe percentage copper saving of an autotransformer can be easily found by taking the ratio of low voltage side to high voltage side. Such asPercentage copper saving = VL/VH x 100%As the voltage corresponds the turns in the winding, so the percentage copper saving can also be calculated as;Percentage copper saving = NL/NH x 100%WhereNL = number of turns on the low voltage sideNH = Number of turns on the high voltage sideRelated Post:Transformer Losses Types of Energy Losses in a TransformerAdvantages of Autotransformer:The most prominent feature of an autotransformer is that it saves copper. The amount of copper used in an autotransformer is less than a two winding transformer of the same ratings. Thus it reduces the capital required for its construction.The single winding used in the autotransformer significantly reduces its size & weight.Having small size & weight of the autotransformer, it enables it to have a high VA rating than an ordinary two winding transformer for the same amount of material.The voltage regulation is much better than the two-winding transformer because of the elimination of the losses in the second winding.Due to the electrical conduction, magnetic induction & reduction in the losses due to the second winding, the efficiency of the autotransformer is higher than the two-winding transformer.Related Post:EMF Equation Of a TransformerDisadvantages of Auto transformer:There is no electrical isolation between the windings. So grounding the primary of an autotransformer wont eliminate the risk of an electrical shock as both windings are electrically connected. The circuit will still complete through the ground.Due to the electrical isolation present between the winding, two winding transformer blocks the transfer of harmonics between the load & supply, while autotransformer actually cant.Because of the low leakage flux between primary & secondary, the impedance of the autotransformer is low. Thus it may result in large fault currents in the secondary.Related Post:Maintenance of Transformer Power Transformers Maintenance, Diagnostic & MonitoringApplications of Autotransformer:They are used for the compensation of the voltage drop in the distribution transformers.For starting induction & synchronous motors, several methods are used. One of the methods is using an autotransformer.A variable autotransformer also known as Variac, which has continuous variable output voltage is used in the laboratories.A break in the common winding of the autotransformer will result in full input voltage at the load.Related Posts: Unlike two winding transformer, an auto-transformer contains only one winding. This single winding serves the purpose of both primary as well as secondary. As this transformer employs only one winding, it uses less copper. Hence it is cheaper and more efficient. The principle of operation of an auto-transformer is same as that of two winding transformer the only difference is the primary and secondary are not electrically separated. The transformation ratio of an auto-transformer is around unity. Types of AutotrnasformerThere are two types of auto-transformers. They are,Step-up auto-transformerStep-down auto-transformer.Construction of AutotransformerEven though the working principle of two winding transformer and an auto-transformer is same but power transfer in both the transformers is somewhat different. In a two winding transformer the power transfer is purely inductive whereas in case of auto-transformer, the power transfer from primary to secondary winding is both inductive and conductive. In an auto-transformer the power transfer is inductive because of the mutual induction and is conductive because both the windings i.e., primary and secondary are electrically in contact with each other.Both step-up auto-transformer and step-down auto-transformer along with direction of flow of currents are shown in figures (l) and (2) respectively. In step-up transformer, the winding from section BC is the primary winding and the winding of section AB is the secondary winding. Hence primary winding BC is a part of secondary winding AB. Therefore, the voltage at secondary is more than the primary voltage and the transformer acts as step-up transformer. Also the condition N2 > N1 satisfies in this transformer. In figure (2) the arrangement of step-down transformer is shown where the entire winding AB is the primary winding and BC acts as the secondary winding. Therefore, secondary winding is a part of primary winding and the transformer acts as step-down transformer. For this case (N1 > N2) and (V1 > V2).Saving of Copper in AutotransformerFor any winding, coppers weight is proportional to the area of cross-section and length of the conductors. But it is known that the area and length of the copper winding are in turn proportional to the current and number of turns respectively. Hence it can be concluded that the weight of the copper used for winding is proportional to the product of current and number of turns.Rating of two types of transformers is identical i.e., both the transformers have equal voltage ratio \(\left(\frac{{{V}_{1}}}{{{V}_{2}}} \right)\), same input and output, maximum flux density and area of core are assumed to be equal.Weight of copper Current in winding Number of turns of winding INWeight of copper in two winding transformer,wT (Copper weight of primary + Copper weight of secondary)\\(\)And also,Weight of copper in auto-transformer,wA (Copper weight of AC + Copper weight of BC)\\(\)Now, taking the ratio of two weights, we get,\[\frac{{{w}_{T}}}{{{w}_{A}}}=\frac{{{I}_{1}}{{N}_{1}}+{{I}_{2}}{{N}_{2}}}{{{I}_{1}}{{N}_{1}}-{{I}_{1}}{{N}_{2}}+{{I}_{2}}{{N}_{2}}-{{I}_{1}}{{N}_{2}}}\]\[\frac{{{w}_{T}}}{{{w}_{A}}}=\frac{{{I}_{1}}{{N}_{1}}+{{I}_{2}}{{N}_{2}}}{{{I}_{1}}{{N}_{1}}+{{I}_{2}}{{N}_{2}}-2{{I}_{1}}{{N}_{2}}}\]\[\frac{{{w}_{T}}}{{{w}_{A}}}=\frac{{{I}_{1}}{{N}_{1}}\left[\frac{{{N}_{1}}}{{{N}_{2}}}+\frac{{{I}_{2}}}{{{I}_{1}}} \right]}{{{I}_{1}}{{N}_{1}}\left[\frac{{{N}_{1}}}{{{N}_{2}}}+\frac{{{I}_{2}}}{{{I}_{1}}}-2 \right]}\]We know that,\[\frac{{{N}_{1}}}{{{N}_{2}}}=\frac{{{I}_{2}}}{{{I}_{1}}}=\frac{1}{K}\]\[\frac{{{w}_{T}}}{{{w}_{A}}}=\frac{\frac{1}{K}+\frac{1}{K}}{\left(\frac{1}{K}+\frac{1}{K}-2 \right)}\]\[\frac{{{w}_{T}}}{{{w}_{A}}}=\frac{\frac{2}{K}}{\frac{2-2K}{K}}\]\[\frac{{{w}_{T}}}{{{w}_{A}}}=\frac{2}{2(1-K)}\]\[\frac{{{w}_{T}}}{{{w}_{A}}}=\frac{1}{(1-K)}\]\[{{w}_{T}}(1-K)={{w}_{A}}\]\[{{w}_{A}}={{w}_{T}}(1-K)\]The above equation is the weight of copper in auto-transformer when compared to two winding transformer.Thus,Saving in copper = Copper weight in two winding transformer Copper weight in auto-transformer\[={{w}_{T}}-{{w}_{A}}\]\[={{w}_{T}}-{{w}_{T}}(1-K)\]\[={{w}_{T}}-{{w}_{T}}+K{{w}_{T}}\]\[\text{Saving in copper = }K{{w}_{T}}\]The above saving is for step down auto-transformer.Similarly for step-up auto-transformer,\[\text{Saving in copper = }\frac{1}{K}{{w}_{T}}\]Advantages of AutotransformerHigh volt-ampere rating can be transferred.Voltage variation is smooth and continuous.Amount of copper required is less.Higher voltage regulation due to less resistance and leakage reactance.Efficiency is more.It is economical due to its small size.Applications of AutotransformerAutotransformers are used as starter for securely starting the machines like induction motor and synchronous motors.These are used as boosters to provide a small boost to a distribution cable to compensate the voltage drop.These are also used as furnace transformers for providing required supply to the furnaces.These are used as inter connecting transformers in 132 kV/330 kV systems.These are also used as variac.These are used in various control systems and home appliances.We work with you, our customer, to ensure you get what you need, where you need it, when you need it. 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What does an autotransformer do. What is the purpose of an autotransformer. Typical applications of an autotransformer.