بسم الله الرحمن الرحيم

***In the name of Allah, the Beneficent, the Merciful*.**

English for the Students of Electrical Engineering

By

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«سپاس خدای را که به ید قدرت بی منتهایش دریای آفرینش را جاری کرد و به اراده ازلی اش همه خلق را صورت بخشید؛ هر کس را در سایه اراده اش به راهی راهرو گردانید و آتش عشق خود را در وجودشان برانگیخت.»

کتاب حاضر که نتیجه سالها تدریس مؤلفین است قدمی کوچک در راه آشنا کردن دانشجویان رشته مهندسی برق با اصطلاحات و واژگان انگلیسی این رشته است. کتاب دوازده فصل دارد و هر فصل شامل دو متن درک مطلب و تمرینهای متنوع برای گسترش دامنه واژگان دانشجویان است. مزیتی که این کتاب نسبت به کتابهای مشابه دارد این است که در انتخاب متون انگلیسی به تمام گرایشهای رشته برق توجه شده و مقالاتی در زمینه برق قدرت، الکترونیک، کنترل و مخابرات ارائه شده است. متونی که در قالب درک مطلب یک در کتاب گنجانده شده برای دانشجویان دوره کارشناسی و کارشناسی ارشد و درک مطلب دوم که به مراتب ساده تر است برای دانشجویان کاردانی توصیه می شود. علاوه بر این، سعی شده از تمام لغات و اصطلاحات اصلی رشته برق استفاده شود تا دانشجویان بعد از خواندن کل کتاب با این لغات آشنا شوند. مهمترین مزیت این کتاب وجود تمرین های مختلف برای یادگیری آسانتر است، بدین معنی که لغات و اصطلاحات جدید در قالب تمرین های مختلف چند بار تکرار شده است.

با کمال فروتنی امیدواریم کوششی که در راه فراهم آوردن این کتاب شده سودمند افتد، هرچند نیک آگاهیم که تنها ذات خداوند کمال مطلق است و این اثر چون سایر مصنوعات بشری از عیب و خلل عاری نیست. بنابراین از صاحب نظران و اساتید محترم تقاضا داریم کاستی ها را به دیده اغماض بنگرند.به گفته سعدی:

شنیدم که در روز امید و بیم   بدان را به نیکان ببخشد کریم

تو نیز ار بدی بینیم در سخن   به خلق جهان آفرین کار کن

بدون شک هیچ کتابی به تنهایی نوشته و چاپ نمی شود، بلکه حاصل همفکری، نقد و همکاری یک مجموعه است . بنابراین لازم می دانیم از زحمات سرکار خانم قاسمی، مدیر انتشارات دانشگاه آزاد اسلامی واحد بندرعباس و همکارانشان سپاسگزاری نماییم. اگر پی گیری ها و حمایت های ایشان نبود قطعا این مهم به سرانجام نمی رسید.
انصافاً کسانی که بیش از همه سختیهای تالیف این کتاب را متحمل شده اند خانواده های عزیزمان هستند که با سعه صدر و شکیبایی امکان نوشتن این کتاب را برایمان فراهم کردند. صمیمانه از آنها تشکر می کنیم وبر نعمت وجودشان خداوندرا شاکریم.

زمستان ۹۵

نوشین اسدی پیران، سارا صاحب هنر،آیدین یوسفی جاوید

“Praise belongs to God Who originated the creatures through His power with an origination and devised them in accordance with His will with a devising. Then He made them walk on the path of His desire, and sent them out on the way of His love.”

The present book ,written by lecturers in English who have taught Technical English to students of electrical engineering for more than a decade, is a small step toward familiarizing the students of electrical engineering with the terms and expressions of this field. This book has 12 chapters, each of which includes two comprehension texts and various drills to improve students’ vocabulary. Moreover, all branches of electrical engineering have been taken into account while choosing the English texts. Thus, this books is composed of different articles on power , electronics, control systems and telecommunications. The texts presented as passage 1, are suggested for graduate and post graduate students whereas the texts presented as passage 2,which are easier to understand, are recommended for students studying for an associate degree.

We sincerely hope that this book will assist electrical engineering students in learning English. However, we know well that this book is not error-free.Hence,we hope that the readers will ignore the shortcomings of this book. As Sa’di says:

On the Day of Judgment the wicked will be
Forgiven, through them that have purity.
If in my words thou evil find,
Do likewise, forgive, for more is behind.

No book is ever written alone. It takes the contribution, criticism and assistance of many people to produce even a small volume such as this one. Therefore, we would like to express our sincere gratitude to

Ms.Ghasemi, and her colleagues in Islamic Azad University of Bandar Abbas Press who took a kind interest in the present manuscript and offered support and encouragement.
A very special thanks goes to our dear families who patiently bore with us during the completion of this work. Without their constant love and support we literally could not have completed this work.

February 2017
Noushin Asadi Piran, Sara Sahebhonar, Aydin Yousefi Javid

Dedicated with love to our
little angels Janan and
Yasamin that remind us:
"miracles happen every day".

Table of Contents

UNIT ONE

Vocabulary: pronunciation, definition and example

Appliance: /əˈplaɪəns/ a device or piece of equipment designed to perform a specific task
Coffee maker and electric kettle are two examples of small appliances in a kitchen.

Attach: /əˈtætʃ/ join or fasten (something) to something else
Electrons are attached to the nucleus of an atom by the electromagnetic force.

Attract: /əˈtrækt/ exert a force on (an object) which is directed towards the source of the force
An electron repels an electron and attracts a proton.

Charge: /tʃɑrdʒ/ the amount or type of electrical force that something has
The protons have a positive charge, and the electrons have a negative charge.

Conduct: /kənˈdʌkt/ transmit (a form of energy such as heat or electricity)
Materials which do conduct electricity, like copper, are called conductors.

Conductor: /kənˈdʌktər/ a material or device that conducts or transmits heat or electricity, especially when regarded in terms of its capacity to do this
Most polymers are poor conductors.

Copper: /ˈkɑpər/ a red-brown metal, the chemical element of atomic number 29
Copper is used in electric wiring.

Current: /ˈkərənt/ a flow of electricity which results from the ordered directional movement of electrically charged particles
Magnetic fields are produced by currents flowing in the cables.

Device: /dɪˈvaɪs/ a thing made or adapted for a particular purpose, especially a piece of mechanical or electronic equipment
A generator is a device that converts mechanical energy to electrical energy for use in an external circuit.

Element: /ˈɛləmənt/ each of more than one hundred substances that cannot be chemically interconverted or broken down into simpler substances and are primary constituents of matter
There are 118 elements that have been identified.

Flow: /floʊ/ (of a liquid, gas, or electricity) move steadily and continuously in a current or stream
Direct current flows in one direction.

Insulator: /ˈɪnsəˌleɪt̬ər/a substance or device which does not readily conduct electricity
Air, cloth and rubber are good electrical insulators.

Ion: /ˈaɪən/ an atom or molecule with a net electric charge due to the loss or gain of one or more electrons

The negatively charged ions attract particles of dust.

Matter: /ˈmæt̬ər/ substance in general, as distinct from mind and spirit; (in physics) that which occupies space and possesses rest mass, especially as distinct from energy
The particles that make up matter are called atoms.

Measure: /ˈmɛʒər/ ascertain the size, amount, or degree of (something) by using an instrument or device marked in standard units
You can measure AC voltage with a multi meter.

Neutral: /ˈnutrəl/not electrically charged
The number of electron or proton present in a neutral atom is called atomic number.

Particle: /ˈpɑrt̬ɪkl/ any of numerous subatomic constituents of the physical world that interact with each other, including electrons, neutrinos, photons, and alpha particles.
Electrical current is the flow of charged particles.

Power: /ˈpaʊər/to supply with electricity or other means of power
Atomic energy powers the new submarines.

Structure: /ˈstrʌktʃər/ the arrangement of and relations between the parts or elements of something complex
Water has a simple molecular structure. It is composed of one oxygen atom and two hydrogen atoms.

Resistance: /rɪˈzɪstəns/the degree to which a substance or device opposes the passage of an electric current, causing energy dissipation. By Ohm’s law resistance (measured in ohms) is equal to the voltage divided by the current.
Resistance was discovered by Georg Simon Ohm in 1827.

Wire: /ˈwaɪər/ metal drawn out into the form of a thin flexible thread or rod
We need a coil of copper wire.

Reading Passage 1

What is Electricity?

Electricity figures everywhere in our lives. Electricity lights up our homes, cooks our food, **powers** our computers, television sets, and other electronic **devices.** Electricity from batteries keeps our cars running and makes our flashlights shine in the dark.

Here's something you can do to see the importance of electricity. Take a walk through your university, house or apartment and write down all the different **appliances**, devices and machines that use electricity. You'll be amazed at how many things we use each and every day that depend on electricity.

But what is electricity? Where does it come from? How does it work? Before we understand all that, we need to know a little bit about atoms and their **structure.**

All **matter** is made up of atoms, and atoms are made up of smaller **particles**. The three main particles making up an atom are the proton, the neutron and the electron.

Electrons spin around the center, or nucleus, of atoms, in the same way the moon spins around the earth. The nucleus is made up of neutrons and protons.

Electrons contain a negative **charge**, protons a positive charge. Neutrons are **neutral** – they have neither a positive nor a negative charge.

There are many different kinds of atoms, one for each type of **element**.

An atom is a single part that makes up an element. There are 118 different known elements that make up everything! Some elements like oxygen we breathe are essential to life.

Each atom has a specific number of electrons, protons and neutrons. But no matter how many particles an atom has, the number of electrons usually needs to be the same as the number of protons. If the numbers are the same, the atom is called balanced, and it is very stable.

So, if an atom had six protons, it should also have six electrons. The element with six protons and six electrons is called carbon. Carbon is found in abundance in the sun, stars, comets, atmospheres of most planets, and the food we eat. Coal is made of carbon; so are diamonds.

Some kinds of atoms have loosely **attached** electrons. An atom that loses electrons has more protons than electrons and is positively charged. An atom that gains electrons has more negative particles and is negatively charged. A "charged" atom is called an "**ion**."

Electrons can be made to move from one atom to another. When those electrons move between the atoms, a **current** of electricity is created. The electrons move from one atom to another in a "**flow**." One electron is attached and another electron is lost.

This chain is similar to the fire fighter's bucket brigades in olden times. But instead of passing one bucket from the start of the line of people to the other end, each person would have a bucket of water to pour from one bucket to another. The result was a lot of spilled water and not enough water to douse the fire. It is a situation that's very similar to electricity passing along a wire and a circuit. The charge is passed from atom to atom when electricity is "passed."

Scientists and engineers have learned many ways to move electrons off of atoms. That means that when you add up the electrons and protons, you would wind up with one more proton instead of being balanced.

Since all atoms want to be balanced, the atom that has been "unbalanced" will look for a free electron to fill the place of the missing one. We say that this unbalanced atom has a "positive charge" (+) because it has too many protons.

Since it got kicked off, the free electron moves around waiting for an unbalanced atom to give it a home. The free electron charge is negative, and has no proton to balance it out, so we say that it has a "negative charge" (-).

So what do positive and negative charges have to do with electricity?

Scientists and engineers have found several ways to create large numbers of positive atoms and free negative electrons. Since positive atoms want negative electrons so they can be balanced, they have a strong **attraction** for the electrons. The electrons also want to be part of a balanced atom, so they have a strong attraction to the positive atoms. So, the positive attracts the negative to balance out.

The more positive atoms or negative electrons you have, the stronger the attraction for the other. Since we have both positive and negative charged groups attracted to each other, we call the total attraction "charge".

Energy also can be **measured** in joules. Joules sounds exactly like the word jewels, as in diamonds and emeralds. A thousand joules is equal to a British thermal unit.

When electrons move among the atoms of matter, a **current** of electricity is created. This is what happens in a piece of **wire**. The electrons are passed from atom to atom, creating an electrical current from one end to other, just like in the picture.

Electricity is **conducted** through some things better than others do. Its **resistance** measures how well something conducts electricity. Some things hold their electrons very tightly. Electrons do not move through them very well. These things are called **insulators**. Rubber, plastic, cloth, glass and dry air are good insulators and have very high resistance.

Other materials have some loosely held electrons, which move through them very easily. These are called **conductors**. Most metals – like **copper**, aluminum or steel – are good conductors.

I. Answer the following questions based on reading passage 1

1. How is a current of electricity created?

2. What is nucleus made up of?

3. What are the main particles which make up an atom?

4. Where is carbon found?

II. Decide if the following statements about reading passage1 are true or false

1. All things conduct electricity in the same way.
2. Insulators have some loosely held electrons.
3. The number of electrons in an atom is the same as that of protons.
4. Diamonds are made of coal.

III. Fill in the blank with the proper word

current-resistance-conductor-flow-measuring-insulators-wire-conduct

1. Iron is a good .... of electricity but not the best.
2. Certain things, such as cold glass, never ....electricity.
3. A metal .... is a common electrical conductor.
4. Semiconductors don't conduct as well as conductors, but can carry.....................
5. An electrical insulator is a material whose internal electric charges do not..................freely.
6. The SI unit for.......................... an electric current is the ampere.
7........................., discovered by Georg Simon Ohm in 1827, is the ratio between voltage and current.
8. Most non-metallic solids are said to be good.................

IV. Fill in the blanks with words from reading passage1

1. A tough elastic polymeric substance made from the latex of a tropical plant or synthetically: .....
2.The SI unit of work or energy: ....

3.A person who designs, builds, or maintains engines, machines, or structures: .....

4.The positively charged central core of an atom, consisting of protons and neutrons and containing nearly all its mass: ....

V. Fill in the blanks with the best derivation of the words given

Electricity

1.John studies..................engineering.

2. An .... is a person who installs, operates, maintains, or repairs electric devices or electrical wiring.

3.Who invented................?

Conduct

1.Metals ....electricity.

2.Copper is a good..............

3. The …………….. of a fluid is expressed in Siemens/centimeters.

Attract

1. Magnets can either ....or repel each other.

2. Magnetism is a force of.................. or repulsion that acts at a distance.

3. The negatively charged ions…………. particles of dust.

Reading Passage 2

Georg Simon Ohm, (born March 16, 1789, Erlangen, Bavaria [Germany]—died July 6, 1854, Munich), German physicist who discovered the law, named after him, which states that the current flow through a conductor is directly proportional to the potential difference (voltage) and inversely proportional to the resistance.

Ohm became professor of mathematics at the Jesuits' College at Cologne in 1817. The most important aspect of Ohm's law is summarized in his pamphlet *Die galvanische Kette, mathematisch bearbeitet* (1827; *The Galvanic Circuit Investigated Mathematically*). While his work greatly influenced the theory and applications of current electricity, it was so coldly received that Ohm resigned his post at Cologne. He accepted a position at the Polytechnic School of Nürnberg in 1833. Finally his work began to be recognized; in 1841 he was awarded the Copley Medal of the Royal Society of London and was made a foreign member a year later. The ohm, the physical unit measuring electrical resistance, also was named for him.

Answer the following questions based on reading passage 2

1. What did ohm teach at the Jesuits' college?

2. Why did he resign his post?

3. Where was Ohm originally from?

UNIT TWO

Vocabulary: pronunciation, definition and example

Alternation current: an electric current that reverses its direction many times a second at regular intervals, typically used in power supplies
LED lights require a transformer to turn alternating current to direct current.

Brush: /brʌʃ/ a piece of carbon or metal serving as an electrical contact with a moving part in a motor or alternator
A brush is a device which conducts current between stationary wires and moving parts, most commonly in a rotating shaft.

Circuit: /ˈsərkət/ a system of electrical conductors and components forming an electrical circuit
He cannot list the major components in an electrical circuit even though they were described in the chapter.

Direct current: an electric current flowing in one direction only
An integral inverter changes the direct current to alternating current for transmission into the facility's electrical distribution systems.

Dissipate: /ˈdɪsəˌpeɪt/ cause (energy) to be lost through its conversion to heat

There's a reduction in efficiency as energy is dissipated in heat.

Distribution: /ˌdɪstrəˈbyuʃn/ the action of sharing something out among a number of recipients
An electric power distribution system is the final stage in the delivery of electric power.

Generate: /ˈdʒɛnəˌreɪt/ produce (energy, especially electricity)
Electricity is generated by the power station during peak demand periods.

Induction: /ɪnˈdʌkʃn/ the production of an electric current in a conductor by varying the magnetic field applied to the conductor
According to Faraday's laws of electromagnetic induction, a changing magnetic field can induce electric current to flow in any conductive structure nearby.

Load : /loʊd/ the amount of electricity supplied by a generating system at any given time

Two fully independent AC and DC electrical systems are each capable of supplying all essential loads.

Magnetic field: a region around a magnetic material or a moving electric charge within which the force of magnetism acts
Electrons produce a small magnetic field as they spin and orbit the nucleus of an atom.

Output: /ˈaʊtpʊt/ the power, energy, or other results supplied by a device or system
Cascading the device increases voltage output.

Polarity: /pəˈlærət̮i/ the property of having poles or being polar
It exhibits polarity when presented to a magnetic needle.

Revolution: /ˌrɛvəˈluʃn/ the movement of an object in a circular or elliptical course around another or about an axis or centre
Revolutions per minute refer to the number of full rotations completed in one minute around a fixed axis.

Shaft: /ʃæft/ a long cylindrical rotating rod for the transmission of motive power in a machine
Escalators are big, complicated machines packed into tight shafts .

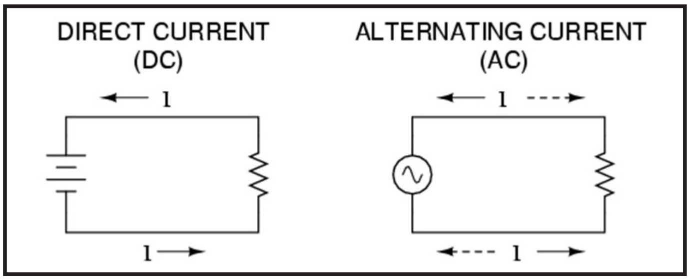
Terminal: /ˈtərmənl/ a point of connection for closing an electric circuit
A circuit arrangement for supplying a discharge lamp with a direct current includes input terminals for connection to a supply voltage source.

Reading Passage 1

What Is Alternating Current (AC)?

Most students of electricity begin their study with what is known as ***direct current*** (DC), which is electricity flowing in a constant direction, and/or possessing a voltage with constant **polarity**. DC is the kind of electricity made by a battery (with definite positive and negative **terminals**), or the kind of charge **generated** by rubbing certain types of materials against each other.

As useful and as easy to understand as DC is, it is not the only "kind" of electricity in use. Certain sources of electricity (most notably, rotary electro-mechanical generators) naturally produce voltages alternating in polarity, reversing positive and negative over time. Either as a voltage switching polarity or as a current switching direction back and forth, this "kind" of electricity is known as **Alternating Current** (AC): Figure below

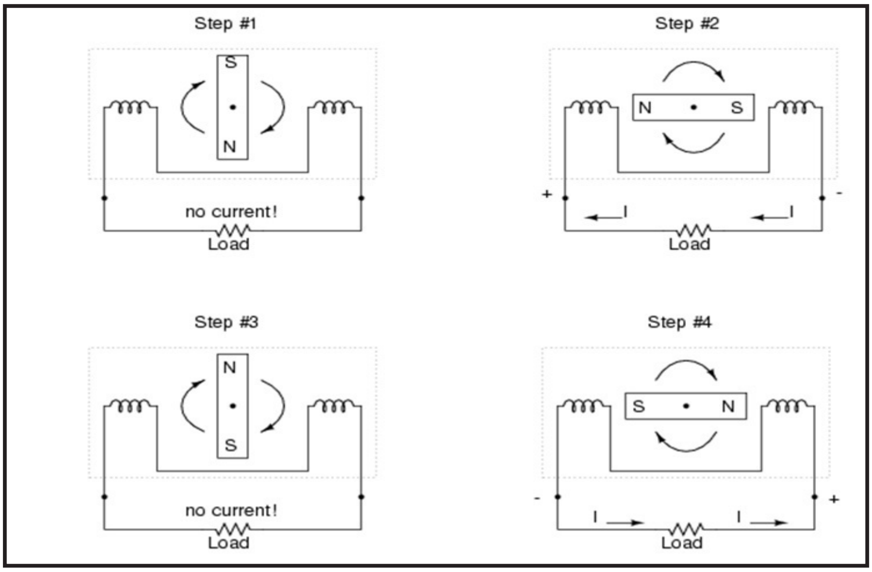


Direct vs alternating current

Whereas the familiar battery symbol is used as a generic symbol for any DC voltage source, the circle with the wavy line inside is the generic symbol for any AC voltage source.

One might wonder why anyone would bother with such a thing as AC. It is true that in some cases AC holds no practical advantage over DC. In applications where electricity is used to **dissipate** energy in the form of heat, the polarity or direction of current is irrelevant, so long as there is enough voltage and current to the **load** to produce the desired heat (power dissipation). However, with AC it is possible to build electric generators, motors and power **distribution** systems that are far more efficient than DC, and so we find AC used predominately across the world in high power applications. To explain the details of why this is so, a bit of background knowledge about AC is necessary.

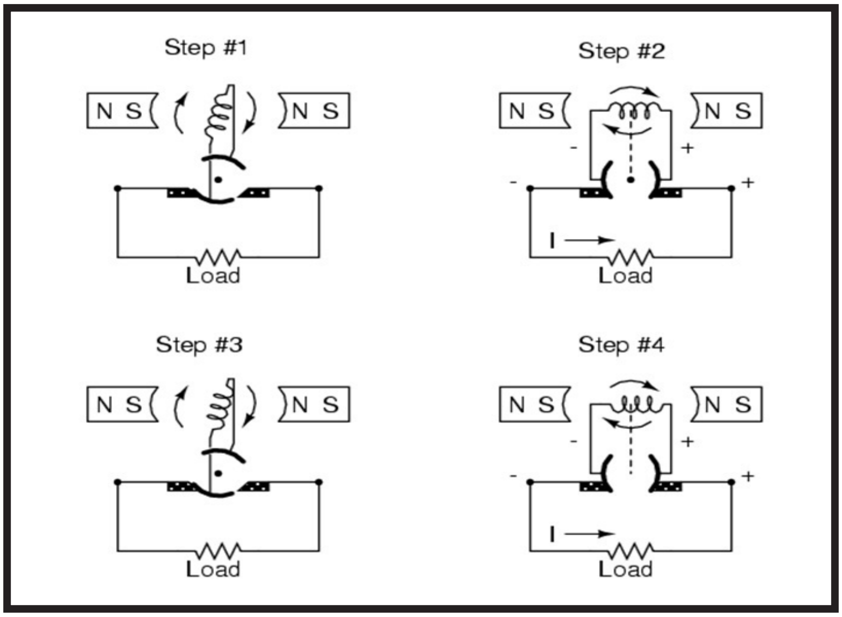
If a machine is constructed to rotate a **magnetic field** around a set of stationary wire coils with the turning of a **shaft**, AC voltage will be produced across the wire coils as that shaft is rotated, in accordance with Faraday's Law of electromagnetic **induction**. This is the basic operating principle of an AC generator, also known as an alternator: Figure below



Alternator operation

Notice how the polarity of the voltage across the wire coils reverses as the opposite poles of the rotating magnet pass by. Connected to a load, this reversing voltage polarity will create a reversing current direction in the circuit. The faster the alternator's shaft is turned, the faster the magnet will spin, resulting in an alternating voltage and current that switches directions more often in a given amount of time.

While DC generators work on the same general principle of electromagnetic induction, their construction is not as simple as their AC counterparts. With a DC generator, the coil of wire is mounted in the shaft where the magnet is on the AC alternator, and electrical connections are made to this spinning coil via stationary carbon "**brushes**" contacting copper strips on the rotating shaft. All this is necessary to switch the coil's changing **output** polarity to the external **circuit** so the external circuit sees a constant polarity: Figure below



DC generator operation

The generator shown above will produce two pulses of voltage per **revolution** of the shaft, both pulses in the same direction (polarity). In order for a DC generator to produce *constant* voltage, rather than brief pulses of voltage once every 1/2 revolution, there are multiple sets of coils making intermittent contact with the brushes. The diagram shown above is a bit more simplified than what you would see in real life.

The problems involved with making and breaking electrical contact with a moving coil should be obvious (sparking and heat), especially if the shaft of the generator is revolving at high speed. If the atmosphere surrounding the machine contains flammable or explosive vapors, the practical problems of spark-producing brush contacts are even greater. An AC generator (alternator) does not require brushes and commutators to work, and so is immune to these problems experienced by DC generators.

The benefits of AC over DC with regard to generator design is also reflected in electric motors. While DC motors require the use of brushes to make electrical contact with moving coils of wire, AC motors do not. In fact, AC and DC motor designs are very similar to their generator counterparts , the AC motor being dependent upon the reversing magnetic field produced by alternating current through its stationary coils of wire to rotate the rotating magnet around on its shaft, and the DC motor being dependent on the brush contacts making and breaking connections to reverse current through the rotating coil every 1/2 rotation (180 degrees).

I. Answer the following questions based on reading passage 1

1. Why is alternating current used in high power applications?

2. Who invented the law of electromagnetic induction?

3. Where is the coil of wire mounted in a DC generator?

4. What is the benefit of AC over DC with regard to generator design?

II. Decide if the following statements about reading passage1 are true or false

1.The construction of AC generators is simpler than their DC counterparts.
2. A battery with positive and negative terminals produces DC.
3. DC generators require brushes and commutators to work.
4. Rubbing certain types of materials against each other results in AC.

III. Fill in the blank with the proper word

induction-polarity - direct current - load - brushes - terminals - alternating current - distribution

1. The main function of an electrical power ………………….. system is to provide power to individual consumer premises.
2. This generator converts mechanical energy into electricity by magnetic ……………………….
3. In ………………….the flow of electric charge is only in one direction.
4. It's a wonderful piece of machinery;…………………….and tubes fit

together perfectly.

5. An electrical……………………..is an electrical component or portion of a circuit that consumes electric power.

6. …………………… is an electric current in which the flow of electric charge periodically reverses direction.

7. The pole with relatively more electrons is said to have negative ....

8. Zinc battery …………………offer advantages over those of lead alloy type battery .

IV. Fill in the blanks with words from reading passage1

1. In electronics, it is a path between two or more points along which an electrical current can be carried: ……….

2. A dynamo or similar machine for converting mechanical energy into electricity:…….

3. It is generated when electric charge carriers such as electrons move through space or within an electrical conductor: ……………..

4. An electromotive force or potential difference:………….

V. Fill in the blanks with the best derivation of the words given

Generate

1. Small wind turbines ……………………….. electricity for the place where they are sited, not the national grid.

2.That country relies primarily on coal for power …………………….

*3.*Do you know how a……………works?

Distribute

1. Microgrids are power ……………………systems in which generation is located close to loads.

2. Why does the electric charge ………………itself unevenly on a conductor's surface?

Apply

1. We ……………… the ointment to the cut.

2. The ………………… of heat often helps sore muscles.

3. All household …………….. are now on sale.

Reading Passage 2

Count Alessandro Giuseppe Antonio Anastasio Volta (18 February 1745 – 5 March 1827) was a Lombard physicist known especially for the development of the first electrical cell in 1800. He was born in Como in Lombardy, Italy.Volta worked on the electrophorus that makes a static electric charge in 1775. Volta also studied what we now call capacitance, developing separate means to study both electrical potential V and charge Q, and discovering that for a given object they are proportional. This may be called Volta's Law of Capacitance, and likely for this work the unit of electrical potential has been named the volt. Around 1791 he began to study "animal electricity". In this way he discovered Volta's Law of the electrochemical series, and the law that the electromotive force (emf $\mathcal{E}$) of a galvanic cell. In 1800, he invented the *voltaic pile*, an early electric battery, which made a steady electric current. It is credited as the first electrochemical cell.In honor of his work in the field of electricity, Napoleon made him a count in 1810. A museum in Como, the Voltian Temple, has been built in his honor and exhibits some of the original equipment he used to conduct experiments. In 1881, an important electrical unit, the volt(V), was named in his honor. There have also been innovations and discoveries named after Alessandro Volta including the Chevy Volt, and the Volta Crater on the Moon.

Answer the following questions based on reading passage 2

1. What is the unit of electrical potential?

2. Who was Alessandro Volta?

3. Why did Napoleon make Volta a Count?

UNIT THREE

Vocabulary: pronunciation, definition and example

Angle: /ˈæŋgl/ the space (usually measured in degrees) between two intersecting lines or surfaces at or close to the point where they meet
Bend your elbows at 90-degree angles and keep them close to your body.

Blade: /bleɪd/ the flat cutting edge of a knife, saw, or other tool or weapon
The knife was like a pocket knife, but bigger, the blade was still sharp.

Boiler: /ˈbɔɪlər/ a tank for generating steam under pressure in a steam engine
A boiler is a closed vessel in which water or other fluid is heated.

Cooling tower: a tall, open-topped, cylindrical concrete tower, used for cooling water or condensing steam from an industrial process
Cooling towers provide evaporative cooling for many types of systems.

Fuel: /ˈfyuəl/ material such as coal, gas, or oil that is burned to produce heat or power
Almost all of the fuels used for transportation and the majority of the fuels used for heat and electricity come from petroleum products.

Geothermal: /ˌdʒioʊˈθərml/ relating to or produced by the internal heat of the earth
Some 70 per cent of Iceland's energy needs are met from geothermal sources.

Huge: /hyudʒ/ extremely large
The huge engine has 14 built-in cylinders.

Inlet: /ˈɪnlɛt/ a place or means of entry
Hygienic steam inlet valves are used for the monitored supply of steam in containers or tanks.

Nuclear: /ˈnukliər/ relating to the nucleus of an atom
They are going to build a nuclear power plant in our city.

Power plant: an installation where electrical power is generated for distribution.
The city's main power station was built by Japanese in 1969.

Pressure: /ˈprɛʃər /continuous physical force exerted on or against an object by something in contact with it
High water pressure is major cause of leaks, pipe damage, and wasted water.

Steam: /stim/ the vapor into which water is converted when heated, forming a white mist of minute water droplets in the air
Steam was rising from the mugs of coffee.

Thermal: /ˈθərml/ relating to heat
Water vapor has a low heat capacity and poor thermal conduction.

Reading Passage 1

Turbines, Generators and Power Plants

As you well know, electricity flows through wires to light our lamps, run TVs, computers and all other electrical appliances. But where does the electricity come from?

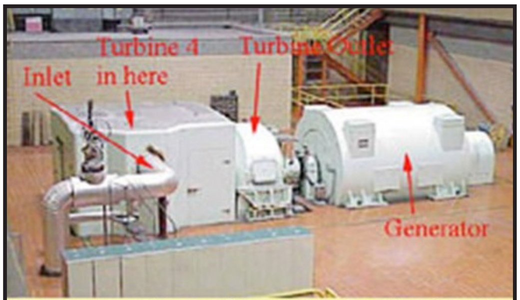


Photo credit: Carl Lira, Mich. State Univ.

In this chapter, we'll learn how electricity is generated in a **power plant**. **Thermal** power plants have big **boilers** that burn a **fuel** to make heat. A boiler is like a teapot on a stove. When the water boils, the **steam** comes through a tiny hole on the top of the spout. The moving steam makes a whistle that tells you the water has boiled. In a power plant, the water is brought to a boil inside the boiler, and the steam is then piped to the turbine through very thick pipes.

In most boilers, wood, coal, oil or natural gas is burned in a firebox to make heat. Running through the fire box and above that hot fire are a series of pipes with water running through them. The heat energy is conducted into the metal pipes, heating the water in the pipes until it boils into steam. Water boils into steam at 212 degrees Fahrenheit or 100 degrees Celsius.

The picture above is of a small power plant located at Michigan State University. The black area to the left of the power plant is coal, the energy source that is burned to heat the water in the boilers of this plant.


Photo credit: Carl Lira, Mich. State Univ.

In the second picture to the right, you'll see the turbine and generator at MSU's power plant. The big pipe on the left side is the steam **inlet**. On the right side of the turbine is where the steam comes out. The steam is fed under high **pressure** to the turbine. The turbine spins and its shaft is connected to a turbogenerator that changes the mechanical spinning energy into electricity.

The third picture below is of the turbine fan before it is placed inside the turbine housing. You can see a close-up of the turbine **blades** on the fourth picture. The turbine has many hundreds of blades that are turned at an **angle** like the blades of a fan. When the steam hits the blades they spin the turbine's shaft that is attached to the bottom of the blades.

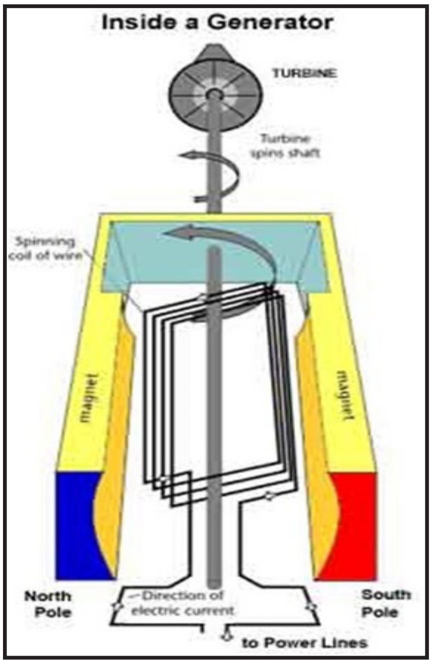

Photo credit:
Carl Lira, Mich. State Univ.

After the steam goes through the turbine, it usually goes to a **cooling tower** outside where the steam cools off. It cools off and becomes water again. When the hot pipes come into contact with cool air, some water vapor in the air is heated and steam is given off above the cooling towers. That's why you see **huge** white clouds sometimes being given off by the cooling towers. It's not smoke, but is water vapor or steam. This is not the same steam that is used inside the turbine.

The cooled water then goes back into the boiler where it is heated again and the process repeats over and over.

Most power plants in California use cleaner-burning natural gas to produce electricity. Others use oil or coal to heat the water. **Nuclear** power plants use nuclear energy to heat water to make electricity. Still others, called **geothermal** power plants, use steam or hot water found naturally below the earth's surface without burning a fuel.

How the Generator Works



The turbine is attached by a shaft to the turbogenerator. The generator has a long, coiled wire on its shaft surrounded by a giant magnet. You can see the inside of the generator coil with all its wires in the picture on the left.

The shaft that comes out of the turbine is connected to the generator. When the turbine turns, the shaft and rotor is turned. As the shaft inside the generator turns, an electric current is produced in the wire. The electric generator is converting mechanical, moving energy into electrical energy.

The generator is based on the principle of "electromagnetic induction" discovered in 1831 by Michael Faraday, a British scientist. Faraday discovered that if an electric conductor, like a copper wire, is moved through a magnetic field, electric current will flow (or "be induced") in the conductor. So the mechanical energy of the moving wire is converted into the electric energy of the current that flows in the wire.

The electricity produced by the generator then flows through huge transmission wires that link the power plants to our homes, school and businesses. All power plants have turbines and generators. Some turbines are turned by wind, some by water, some by steam.

I. Answer the following questions based on reading passage 1

1. What is used to make heat in most boilers?

2. What are the huge white clouds given off by the cooling towers?

3. How is the turbine attached to a turbogenerator?

4. How do you know if water has boiled in a boiler?

II. Decide if the following statements about reading passage1 are true or false

1. A pipe attaches the turbine to a turbogenerator.
2. In a generator, the mechanical energy is converted into the electric energy .
3. Most power plants in California use coal to heat the water.

4. Natural gas is a clean burning fuel.

III.Fill in the blank with the proper word

fuels-angle-stream-nuclear-thermal-blade-huge-pressure

1.A cooling tower is a heat rejection device, which extracts waste heat to the atmosphere though the cooling of a water .... to a lower temperature.
2. The standard unit for …………………is the Pascal, which is a Newton per square meter.
3.Fossil ………………….., including coal, oil and natural gas, are currently the world's primary energy source.
4. ………………….energy is the energy that comes from heat.
5. In any triangle*,* the longest side is opposite the largest …………….
6.Some .... windmills produce energy for California.
7. At a basic level, ……………………power is the practice of splitting atoms to boil water, turn turbines, and generate electricity.
8.Be careful! The …………..of this knife is very sharp.

IV. Fill in the blanks with words from reading passage1

1. It refers to an industrial facility for the generation of electric power: ....
2. An object that attracts iron and some other materials: ……….
3. A tube used to convey water, gas, oil, or other fluid substances: …….
4. The chamber of a steam engine or boiler in which the fuel is burnt: ....

V. Fill in the blanks with the best derivation of the words given

Cool

1.The modern ……………system has not changed much.

2.The……………water goes back into the boiler.

3. The wind kept us…………

Machine

1. In the physical sciences, …………….. energy is the sum of potential energy and kinetic energy.

2. They bought a new washing……….

3. Some of the mill's ………………… was damaged in the fire.

Locate

1. Can you ……………. your town on the map?

2. The police have arrested a………………… man for the crime.

3. The company is moving its factory to a different ……………….

Reading Passage 2

Michael Faraday (Newington Butts, Surrey, 22 September 1791 – Hampton Court, Surrey, 25 August 1867) was an English chemist and physicist. Although Faraday had little school education, and did not know higher mathematics, he became one of the most influential scientists in history. For the most part, he taught himself. Faraday became the greatest experimental physicist of the nineteenth century. At the time when he lived, only a little was known about electricity. Michael Faraday discovered many things about the way electricity flowing in a wire can act like a magnet (now called electromagnetism). He also found out a lot about the way electricity can be used with chemicals to make them change (now called electrochemistry).

He showed that magnetism is able to affect rays of light, as there is an underlying relationship between the two phenomena. His inventions of electromagnetic rotary devices formed the foundation of electric motor technology, and it was largely due to his efforts that electricity became viable for use in technology. He made the first electric motor. It is thanks to his early work that the electricity has been made into a useful thing today.As a chemist, Michael Faraday discovered benzene, invented an early type of Bunsen burner and popularized terminology such as anode, cathode, electrode and ion.

Answer the following questions based on reading passage 2

1.Who was Faraday's real teacher?

2. What did Faraday invent as a chemist?

3.What contribution has he made to electric motors?

UNIT FOUR

Vocabulary: pronunciation, definition and example

Compensate: /ˈkɑmpənˌseɪt /act so as to neutralize or correct (a deficiency or abnormality in a physical property or effect)
The output voltage rises, compensating for the original fall.

Convert: /kənˈvərt/ change the form, character, or function of something
The transmitter converts acoustic energy (the sound of your voice vibrating the diaphragm) into electrical energy.

Dam: /dæm/ a barrier constructed to hold back water and raise its level, forming a reservoir used to generate electricity or as a water supply
Hydropower is often used in conjunction with dams to generate electricity.

Facility: /fəˈsɪləṯi/ a place, amenity, or piece of equipment provided for a particular purpose
A power station is an industrial facility for the generation of electric power.

Feat: /fit/ achievement
The new printing presses were considerable feats of engineering.

Grid: /grɪd/ a network of cables or pipes for distributing power, especially high-voltage transmission lines for electricity

The reactor was connected to the grid in 1985.

Insulate: /ˈɪnsəˌleɪt/ prevent the passage of electricity to or from (something) by covering it in non-conducting material

The electric wire has been insulated with a rubber sheath.

Manipulate: /məˈnɪpyəˌleɪt/ handle or control (a tool, mechanism, information, etc.) in a skilful manner
Electrokinesis is the ability to generate and manipulate electricity.

Overhead: /ˌoʊvərˈhɛd/ situated above the level of the head
Overhead telephone and cable TV lines are common in North America.

Ramp up: /ræmpʌp/ increase the level or amount of (something) sharply
Production was ramped up so that in future they could achieve this level of output.

Shutdown: /ˈʃʌtdaʊn/ a closure of a factory or system, typically a temporary closure due to a fault or for maintenance
A nuclear power plant in Georgia was recently forced into an emergency shutdown for 48 hours.

Solar: /ˈsoʊlər/ relating to or determined by the sun
Any site having solar and electromagnetic energy is good for residence.

Vulnerable: /ˈvʌlnərəbl/ exposed to the possibility of being attacked or harmed, either physically or emotionally
The economy is vulnerable to a rise in the euro exchange rate .

Reading Passage 1

How the Electricity Grid Works

The electricity **grid** is a complex and incredibly important system, and one of the most impressive engineering **feats** of the modern era. It transmits power generated at a variety of **facilities** and distributes it to end users, often over long distances. It provides electricity to buildings, industrial facilities, schools, and homes. And it does so every minute of every day, year-round.

What makes up the electricity grid?

Electricity grid consists of four major components, each of which is detailed below.

Individual Generators

A variety of facilities generate electricity, including coal- and natural gas-burning power plants, hydroelectric **dams**, nuclear power plants, wind turbines, and **solar** panels. The location of these electricity generators – and their distance from end users – varies widely.

These technologies are also physically different, and are used and **manipulated** differently on the power grid as a result. For example, certain types of power plants, such as coal and nuclear power plants, have little short-term flexibility in adjusting their electricity output; it takes a long time to **ramp up** or down their electricity output.

Other plants, such as natural-gas fired plants, can be ramped up very quickly, and are often used to meet peaks in demand. More variable technologies, such as wind and solar photovoltaics, are generally used whenever they are available, in large part because their fuel – sunlight and wind – is free.

At any given time, there is also always a “reserve margin,” a specified amount of backup electricity generating capacity that is available to **compensate** for potential forecasting errors or unexpected power plant **shutdowns**. Electricity demand, supply, reserve margins, and the mix of electricity generating technologies is constantly monitored and managed by grid operators to ensure that everything runs smoothly.

Electricity generators are owned by electric companies, or utilities, which are in turn regulated by the state’s Public Utility Commission (PUC) or the Public Service Commission (PSC). PUCs and PSCs are independent regulatory agencies appointed by the state legislature. Generators can only be built with approval from the PUC or PSC, and these agencies set appropriate electricity rates within their state that the utilities must abide by.

Transmission Lines

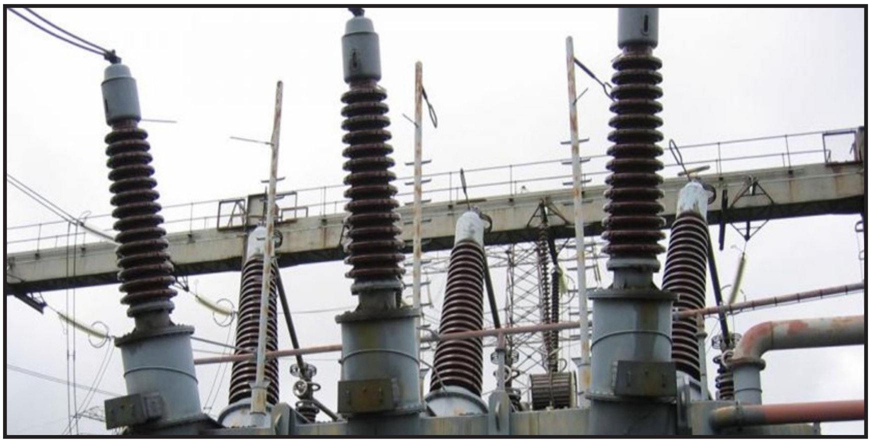
Transmission lines are necessary to carry high-voltage electricity over long distances and connect electricity generators with electricity consumers.Transmission lines are either **overhead** power lines or underground power cables. Overhead cables are not **insulated** and are **vulnerable** to the weather, but can be less expensive to install than underground power cables. Overhead and underground transmission lines are made of aluminum alloy and reinforced with steel; underground lines are typically insulated.

Transmission lines carry high-voltage electricity over long distances. Photo: Nayu Kim/Flickr

Transmission lines carry high voltages because it reduces the fraction of electricity that is lost in transit – about 6% on average in the United States . As electricity flows through the wires, some of it dissipates as heat through a process called resistance. The higher the voltage is on a transmission line, the less electricity it loses. (Most of the electric current flows close to the surface of the transmission line; using thicker wires would have minimal impact on transmission losses.)

Transmission-level voltages are typically at or above 110,000 volts or 110 kV, with some transmission lines carrying voltages as high as 765 kV. Power generators, however, produce electricity at low voltages. In order to make high-voltage electricity transport possible, the electricity must first be **converted** to higher voltages with a transformer.

These high voltages are also significantly greater than what you need in your home, so once the electricity gets close to end users, another transformer converts it back to a lower voltage before it enters the distribution network.



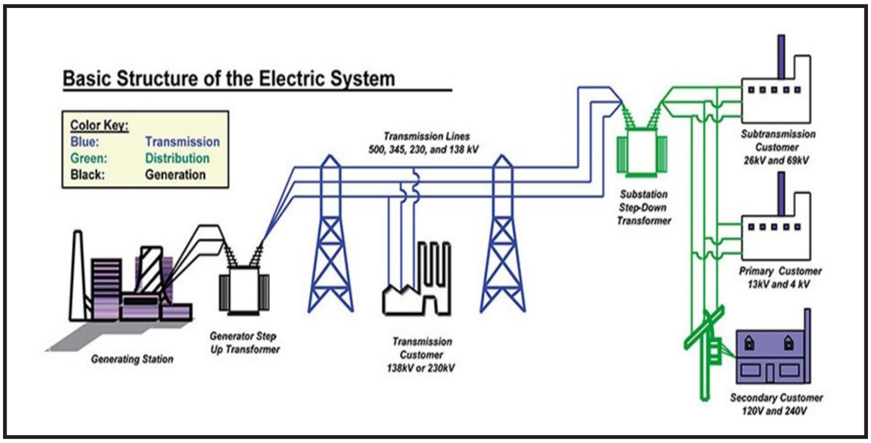
Transformers convert electricity from low to high voltage for long-distance transmission, then convert it back to low voltage for use in homes and other facilities. Photo: Victoria Catterson/Flickr

Distribution

The distribution network is simply the system of wires that picks up where the transmission lines leave off. These networks start at the transformers and end with homes, schools, and businesses. Distribution is regulated on the state level by PUCs and PSCs, who set the retail rates for electricity in each state.

Consumer Use or "Load"

The transmission grid comes to an end when electricity finally gets to the consumer, allowing you to turn on the lights, watch television, or run your dishwasher. The patterns of our lives add up to a varying demand for electricity by hour, day, and season, which is why the management of the grid is both complicated and vital for our everyday lives.



I. Answer the following questions based on reading passage 1

1.What is the advantage of using technologies such as wind and solar photovoltaics?

2. What makes overhead cables vulnerable to the weather?

3. Where does the distribution network end?

4. What happens in the process of resistance?

II. Decide if the following statements about reading passage1 are true or false.

1. Underground power cables are more expensive to install than overhead cables.

2. The grid is managed by consumers whose pattern of lives add up to a varying demand for electricity.

3. Transmission lines carry high voltages to convert electricity into heat.
4. All electricity generators are located at the same distance from the consumers.

III. Fill in the blank with the proper word

solar-grid-insulate-vulnerable-feat-converts-manipulate-dam

1. An electrical ……………..is an interconnected network for delivering electricity from suppliers to consumers.
2. An electric heater is an electrical device that ...………………electric current to heat.
3. Hydroelectric power is produced as water passes through a………, and into a river below.
4. Certain building types are particularly ...……………..to damage in earthquakes.
5. The Eiffel Tower is a remarkable …………of engineering.
6. The ……………..System is made up of all the planets that orbit our Sun.
7. You can………… a house against heat loss by having the windows double-glazed.
8. The wheelchair is designed so that it is easy to ………………..

IV. Fill in the blanks with words from reading passage1

1. Constituting part of a larger whole: ……….
2. Predict or estimate (a future event or trend): …………..
3. Control (something, especially a business activity) by means of rules: ……………
4. The ability to be easily modified:………..

V. Fill in the blanks with the best derivation of the words given

Insulate

1. These materials provide the….……….needed in cold water.
2. Metal is not a good………..
3. They used a special type of fiberglass to……..…the attic.

Convert

1. A voltage…………changes the voltage of an electrical power source.
2. Researchers are developing a new technique to….……..mechanical energy into electricity.
3. The law of…………..…of energy states that the total energy of an isolated system remains constant.

Reduce

1. Stricter speed limit enforcement has …………………the number of car accidents.
2. A ………………in competition is not what consumers want.
3. I thought we were getting overly ……………… and simplistic.

Reading Passage 2

André-Marie Ampère (20 January 1775 – 10 June 1836) was a French physicist and mathematician who helped discover electromagnetism. An electrical unit called the ampere is named after him.

Ampere was born in Lyon, France in 1775. During his childhood, Ampere's father taught him Latin, until he found out that his son was talented in mathematical studies. However, young Ampere continued his study on Latin, so that he could understand and master the works of Euler and Bernoulli. In his later life, Ampere began to distinguish himself in mathematics, but also he studied history, travels, poetry, philosophy, and the natural sciences.

Ampere is most known for establishing the relationship between electricity and magnetism, and combining them into a new field called electromagnetism, or electrodynamics. On September 11, 1820, Ampere heard from the discovery of H.C.Orsted that a magnetic needle can be activated by a voltaic current. Only a week later, he came up with a much more advanced version of that kindred phenomena. It was such a amazing development. On the same day, he also discovered like charges repel and different charges come towards each other.

Answer the following questions based on reading passage 2

1. What is Ampere famous for?

2. What did ampere discover about like charges?

3. Why did Ampere study Latin?

UNIT FIVE

Vocabulary: pronunciation, definition and example
Bash: /bæʃ/ strike hard and violently
They tried to bash the door open.

Boost: /bust/ amplify (an electrical signal)
The specially designed circuit boosts signal strength.

Criss-cross: /ˈkrɪs krɔs/ form a pattern of intersecting lines or paths on (a place)
When 19th century astronomers looked at Mars, many saw lines criss-crossing the planet.

Curl: /kərl/ form or cause to form into a curved or spiral shape
The snake curled itself around its prey.

Enormously: /ɪˈnɔrməsli/ to a very great degree or extent; considerably
Quality of life varies enormously from one place to another.

Explode: /ɪkˈsploʊd/ burst or shatter violently and noisily as a result of

rapid combustion, excessive internal pressure, or other process
The airplane exploded and broke up into a couple of pieces.

Fluctuate: /ˈflʌktʃuˌeɪt/ rise and fall irregularly in number or amount
His popularity has fluctuated during his term in office.

Flux: /flʌks/ the total electric or magnetic field passing through a surface
The magnetic flux is measured by external coils, from which the conductivity inside the object can be calculated.

Jiggle: /ˈdʒʌgl/ move about quickly from side to side or up and down
Heating makes the free electrons jiggle around more energetically.

Mount: /maʊnt/place or fix (an object) on a support
The engine is mounted behind the rear seats.

Pylon: /ˈpaɪlɑn/ a tall tower-like structure used for carrying electricity cables high above the ground
Children living close to electricity pylons face a greater risk of contracting leukaemia.

Transform: /trænsˈfɔrm/ change the voltage of (an electric current)
The wind plant captures and transforms wind energy into direct current electricity.

Transformer: /trænsˈfɔrmər/ an apparatus for reducing or increasing the voltage of an alternating current
A transformer boosted the tube voltage to about 50 000 V.

Turn out: prove to be the case
It turns out there is a job available.

Virtually: /ˈvərtʃuəli/ nearly; almost
The stadium was virtually empty by the time the game ended.

Wiggle: /ˈwɪɡl/ move or cause to move up and down or from side to side with small rapid movements
She took her shoes off then, and wiggled her toes contentedly inside her silk stockings.

Wrap: /ræp/ bend or twist out of shape
A simple electromagnet consists of a coil of insulated wire wrapped around an iron core.

Reading Passage 1

Electricity Transformers

The mighty power lines that **criss-cross** our countryside or wiggle unseen beneath city streets carry electricity at **enormously** high voltages from power plants to our homes. It's not unusual for a power line to be rated at 400,000 to 750,000 volts! But the appliances in our homes use voltages thousands of times smaller—typically just 110 to 250 volts. If you tried to power a toaster or a TV set from an electricity **pylon**, it would instantly **explode**! (Don't even think about trying, because the electricity in overhead lines will almost certainly kill you.) So there has to be some way of reducing the high voltage electricity from power plants to the lower voltage electricity used by factories, offices, and homes. The piece of equipment that does this, humming with electromagnetic energy as it goes, is called a **transformer.** Let's take a closer look at how it works!

Why Do We Use High Voltages?

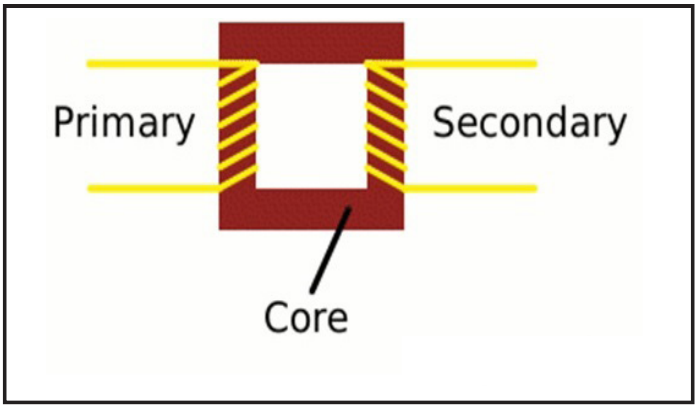
Your first question is probably this: if our homes and offices are using photocopiers, computers, washing machines, and electric shavers rated at 110–250 volts, why don't power stations simply transmit electricity at that voltage? Why do they use such high voltages? To explain that, we need to know a little about how electricity travels.

As electricity flows down a metal wire, the electrons that carry its energy **jiggle** through the metal structure, **bashing** and crashing about and generally wasting energy like unruly schoolchildren running down a corridor. That's why wires get hot when electricity flows through them (something that's very useful in electric toasters and other appliances that use heating elements). It **turns out** that the higher the voltage electricity you use, and the lower the current, the less energy is wasted in this way. So the electricity that comes from power plants is sent down the wires at extremely high voltages to save energy.

But there's another reason too. Industrial plants have huge factory machines that are much bigger and more energy-hungry than anything you have at home. The energy an appliance uses is directly related (proportional) to the voltage it uses. So, instead of running on 110–250 volts, power-hungry machines might use 10,000–30,000 volts. Smaller factories and machine shops may need supplies of 400 volts or so. In other words, different electricity users need different voltages. It makes sense to ship high-voltage electricity from the power station and then **transform** it to lower voltages when it reaches its various destinations. (Even so, centralized power stations are still very inefficient. About two thirds of the energy that arrives at a power plant, in the form of raw fuel, is wasted in the plant itself and on the journey to your home.)

How Does a Transformer Work?

A transformer is based on a very simple fact about electricity: when a **fluctuating** electric current flows through a wire, it generates a magnetic field (an invisible pattern of magnetism) or "magnetic **flux**" all around it. The strength of the magnetism (which has the rather technical name of magnetic flux density) is directly related to the size of the electric current. So the bigger the current, the stronger the magnetic field. Now there's another interesting fact about electricity too. When a magnetic field fluctuates around a piece of wire, it generates an electric current in the wire. So if we put a second coil of wire next to the first one, and send a fluctuating electric current into the first coil, we will create an electric current in the second wire. The current in the first coil is usually called the primary current and the current in the second wire is the secondary current. What we've done here is pass an electric current through empty space from one coil of wire to another. This is called electromagnetic induction because the current in the first coil causes (or «induces») a current in the second coil. We can make electrical energy pass more efficiently from one coil to the other by **wrapping** them around a soft iron bar (sometimes called a core):

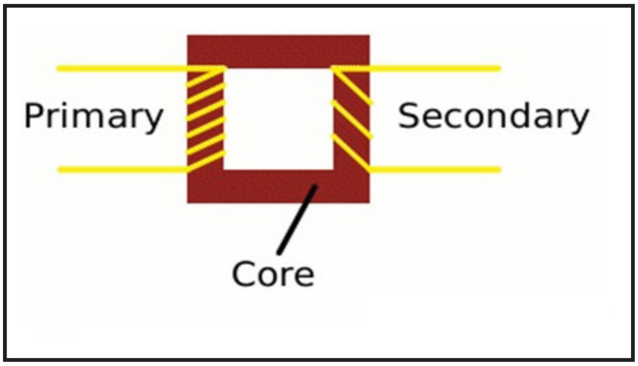


To make a coil of wire, we simply **curl** the wire round into loops or turns. If the second coil has the same number of turns as the first coil, the electric current in the second coil will be **virtually** the same size as the one in the first coil. But if we have more or fewer turns in the second coil, we can make the secondary current and voltage bigger or smaller than the primary current and voltage.

One important thing to note is that this trick works only if the electric current is fluctuating in some way. In other words, you have to use a type of constantly reversing electricity called alternating current (AC) with a transformer. Transformers do not work with direct current (DC), where a steady current constantly flows in the same direction.

Step-down Transformers

If the first coil has more turns that the second coil, the secondary voltage is smaller than the primary voltage:



This is called a step-down transformer. If the second coil has half as many turns as the first coil, the secondary voltage will be half the size of the primary voltage; if the second coil has one tenth as many turns, it has one tenth the voltage. In general:

Secondary voltage ÷ Primary voltage = Number of turns in secondary ÷ Number of turns in primary

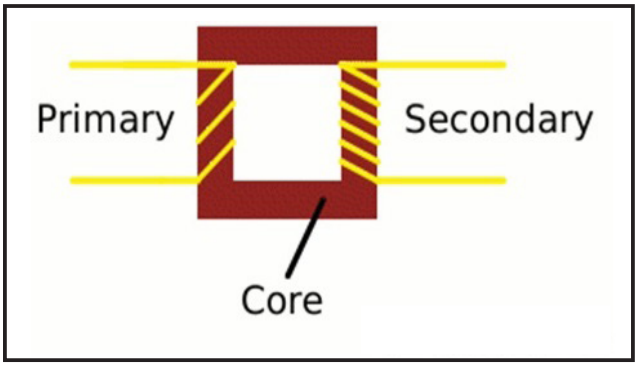
The current is transformed the opposite way—increased in size—in a step-down transformer:

Secondary current ÷ Primary current = Number of turns in primary ÷ Number of turns in secondary

So a step-down transformer with 100 coils in the primary and 10 coils in the secondary will reduce the voltage by a factor of 10 but **multiply** the current by a factor of 10 at the same time. The power in an electric current is equal to the current times the voltage, so you can see the power in the secondary coil is theoretically the same as the power in the primary coil. (In reality, there is some loss of power between the primary and the secondary because some of the "magnetic flux" leaks out of the core, some energy is lost because the core heats up, and so on.)

Step-up Transformers

Reversing the situation, we can make a step-up transformer that **boosts** a low voltage into a high one:



This time, we have more turns on the secondary coil than the primary. It's still true that:

Secondary voltage ÷ Primary voltage = Number of turns in secondary ÷ Number of turns in primary

and

Secondary current ÷ Primary current = Number of turns in primary ÷ Number of turns in secondary. In a step-up transformer, we use more turns in the secondary than in the primary to get a bigger secondary voltage and a smaller secondary current.

Considering both step-down and step-up transformers, you can see it's a general rule that the coil with the most turns has the highest voltage, while the coil with the fewest turns has the highest current.

Transformers in Your Home

As we've already seen, there are lots of huge transformers in towns and cities where the high-voltage electricity from incoming power lines is converted into lower-voltages. But there are lots of transformers in your home also. Big electric appliances such as washing machines and dishwashers use relatively high voltages of 110–240 volts, but electronic devices such as laptop computers and chargers for MP3 players and mobile cellphones use relatively tiny voltages: a laptop needs about 15 volts, an iPod charger needs 12 volts, and a cellphone typically needs less than 6 volts when you charge up its battery. So electronic appliances like these have small transformers built into them (often **mounted** at the end of the power lead) to convert the 110–240 volt domestic supply into a smaller voltage they can use. If you've ever wondered why things like cellphones have those big fat chunky power cords, it's because they contain transformers!

I. Answer the following questions based on reading passage 1

1. Why do wires get hot when electricity flows through them?

2. What is magnetic flux?

3. Why do they ship high-voltage electricity from the power station and then transform it to lower voltages?

4. What is the advantage of wrapping coils around a core?

II. Decide if the following statements about reading passage1 are true or false

1. All electricity users need the same amount of voltage.
2. No energy is wasted at the power plants, but some is wasted through distribution.
3. There's no relation between the strength of the magnetism and the size of the electric current.
4. The electricity that comes from power plants is sent down the wires at extremely high voltages to prevent loss of energy.

III. Fill in the blank with the proper word

curls-fluctuates-exploded-boost-jiggle-mounted-multiply-crisscross

1.The lasers are manufactured to ……….….. the signals of fiber optic cable.
2.Several highways ..………………….. the state.

3.She ………………….. her hair every morning.

4.At higher temperatures, individual electrons ………….. faster, but in a less organized fashion.

5.In the desert, the temperature …………….. dramatically.

6.Engines were …………………on the bottom to help it propel upwards.

7.The teacher taught the children how to add, subtract, ………….., and divide.

8.The approaching tanks …………… in rapid succession and burst into flames.

IV. Fill in the blanks with words from reading passage1

1.Obtain from (a number) another which contains the first number a specified number of times: …..

2.An electrical appliance which makes bread crisp, hot, and brown by heat: …….

3.The place to which someone or something is going or being sent: ……….

4.Disorderly and disruptive and not amenable to discipline or control: ……….

V. Fill in the blanks with the best derivation of the words given

Transform

1.No or low output voltage means the………………… winding has open or shorted winding.

2.The old factory has been……………………… into an art gallery.

3.The building underwent various …………………….. over the years.

Centralize

1.The protons and neutrons cluster together in the …………….. part of the atom.

2.Protons and neutrons are heavier than electrons and reside in the ………… of the atom.

3.…………………..generation facilities in the United States currently have the capacity to generate more than 1,100 gigawatts of electric power.

Explode

1.One of the shells failed to ..………………

2.Three ……………….. damaged buildings.

3.Nitroglycerin is an ……………….. substance.

Reading Passage 2

Joseph Henry, (born December 17, 1797, Albany, New York, U.S.—died May 13, 1878, Washington, D.C.), one of the first great American scientists after Benjamin Franklin. He aided and discovered several important principles of electricity, including self-induction, a phenomenon of primary importance in electronic circuitry.

While working with electromagnets at the Albany Academy (New York) in 1829, he made important design improvements. By insulating the wire instead of the iron core, he was able to wrap a large number of turns of wire around the core and thus greatly increase the power of the magnet. He made an electromagnet for Yale College that could support 2,063 pounds, a world record at the time.

Henry also searched for electromagnetic induction—the process of converting magnetism into electricity—and in 1831 he started building a large electromagnet for that purpose. Because the room at the Albany Academy in which he wanted to build his experiment was not available, he had to postpone his work until June 1832, when he learned that British physicist Michael Faraday had already discovered induction the previous year. However, when he resumed his experiments, he was the first to notice the principle of self-induction.

In 1831 Henry built and successfully operated, over a distance of 2.4 km (1.5 miles), a telegraph of his own design. He became professor of natural philosophy at the College of New Jersey (later Princeton University) in 1832. Continuing his researches, he discovered the laws upon which the transformer is based. He also found that currents could be induced at a distance and in one case magnetized a needle by using a lightning flash 13 km (8 miles) away. That experiment was apparently the first use of radio waves across a distance. He aided Samuel F.B. Morse in the development of the telegraph by giving him 8 km (5 miles) of copper wire and writing a letter to Congress in 1842 encouraging it to support an 80-km (50-mile) test line. By using a thermogalvanometer, a heat-detection device, he showed that sunspots radiate less heat than the general solar surface.

In 1893 his name was given to the standard electrical unit of inductive resistance, the henry.

Answer the following questions based on reading passage 2

1- How did Henry increase the power of the magnet?

2-What is a thermogalvanometer?

3-What is the standard electrical unit of inductive resistance?

UNIT SIX

Vocabulary: pronunciation, definition and example

Axle: /ˈæksl/ a rod or spindle (either fixed or rotating) passing through the center of a wheel or group of wheels
Independent rear axles are similar to front axle of a front wheel drive car.

Commutator: /ˈkɑmyəˌteɪt̬ər/ a device for reversing the direction of flow of electric current
The commutator must switch current to the correct drive magnets in the correct direction at the correct time in order to produce desired rotor movement.

Creep: /krip/ move slowly and carefully
John crept downstairs, hardly making any noise.

Extractor: /ɪkˈstræktər/ an extractor or extractor fan is a device that is fixed to a window or wall to draw smells, steam, or hot air out of a room
An electric oven, hob and extractor fan come with the house.

Flip: /flɪp/ turn over or cause to turn over
The plane flipped over and then exploded.

Loop: /lup/ A shape produced by a curve that bends round and crosses itself
The shape of the loop seems simple but in fact it is not.

Magnetic levitation: refers to a method by which an object is suspended with no support other than magnetic fields
Magnetic levitation is used for maglev trains.

Permanent: /ˈpərmənənt/ lasting or intended to last or remain unchanged indefinitely
Many people work through agencies and then apply for permanent jobs.

Rotate: /ˈroʊteɪt/ move or cause to move in a circle round an axis or center
The wheel continued to rotate.

Rotor: /ˈroʊteɪt/ the rotating member of a machine or device, esp the armature of a motor or generator or the rotating assembly of a turbine
The rotor turns an attached generator, creating electricity with a simple elegance, carving energy from the sky.

Squarish: /ˈskwɛrɪʃ/ somewhat square in form or appearance
He had a stern, squarish jaw, and a rather crooked nose.

Suppose: /səˈpoʊz/ think or assume that something is true or probable but lack proof or certain knowledge
Getting a good job isn't as easy as you might suppose.

Tangle:/ˈtæŋgl/ twist together into a confused mass
She was tangling the phone cord with her index finger.

Temporary: /ˈtɛmpəˌrɛri/ lasting for only a limited period of time; not permanent
You can record programs to the hard drive for temporary storage.

Torque: /tɔrk/ a force that tends to cause rotation
The three-liter engine has lots of torque.

Vertical: /ˈvərt̬ɪkl/ at right angles to a horizontal plane; in a direction, or having an alignment, such that the top is directly above the bottom
The terms vertical and horizontal often describe directions.

Reading Passage 1

Electric Motors

Electric motor refers to any of a class of devices that convert electrical energy to mechanical energy, usually by employing electromagnetic phenomena.

You can find them in everything from electric trains to remote-controlled cars—and you might be surprised how common they are. How many electric motors are there in the room with you right now? There are probably two in your computer for starters, one spinning your hard drive around and another one powering the cooling fan. If you're sitting in a bedroom, you'll find motors in hair dryers and many toys; in the bathroom, they're in **extractor** fans, and electric shavers; in the kitchen, motors are in just about every appliance from clothes washing machines and dishwashers to coffee grinders, microwaves, and electric can openers. Electric motors have proved themselves to be among the greatest inventions of all time. Let's see how they work!

Electricity, Magnetism, and Movement

The basic idea of an electric motor is really simple: you put electricity into it at one end and an **axle** (metal rod) **rotates** at the other end giving you the power to drive a machine of some kind. How does this work in practice? Exactly how do your convert electricity into movement? To find the answer to that, we have to go back in time almost 200 years.

Suppose you take a length of ordinary wire, make it into a big **loop**, and lay it between the poles of a powerful, permanent horseshoe magnet. Now if you connect the two ends of the wire to a battery, the wire will jump up briefly. It's amazing when you see this for the first time. It's just like magic! But there's a perfectly scientific explanation. When an electric current starts to **creep** along a wire, it creates a magnetic field all around it. If you place the wire near a permanent magnet, this **temporary** magnetic field interacts with the **permanent** magnet's field. You'll know that two magnets placed near one another either attract or repel. In the same way, the temporary magnetism around the wire attracts or repels the permanent magnetism from the magnet, and that's what causes the wire to jump.

How an Electric Motor Works—in Theory

The link between electricity, magnetism, and movement was originally discovered in 1820 by French physicist André-Marie Ampère (1775–1867) and it's the basic science behind an electric motor. But if we want to turn this amazing scientific discovery into a more practical bit of technology to power our electric mowers and toothbrushes, we've got to take it a little bit further. The inventors who did that were Englishmen Michael Faraday (1791–1867) and William Sturgeon (1783–1850) and American Joseph Henry (1797–1878). Here's how they arrived at their brilliant invention.

Suppose we bend our wire into a **squarish**, U-shaped loop so there are effectively two parallel wires running through the magnetic field. One of them takes the electric current away from us through the wire and the other one brings the current back again. Because the current flows in opposite directions in the wires, Fleming's Left-Hand Rule tells us the two wires will move in opposite directions. In other words, when we switch on the electricity, one of the wires will move upward and the other will move downward.

If the coil of wire could carry on moving like this, it would rotate continuously—and we'd be well on the way to making an electric motor. But that can't happen with our present setup: the wires will quickly **tangle** up. Not only that, but if the coil could rotate far enough, something else would happen. Once the coil reached the **vertical** position, it would **flip over**, so the electric current would be flowing through it the opposite way. Now the forces on each side of the coil would reverse. Instead of rotating continuously in the same direction, it would move back in the direction it had just come! Imagine an electric train with a motor like this: it would keep shuffling back and forward on the spot without ever actually going anywhere.

How an Electric Motor Works—in Practice

There are two ways to overcome this problem. One is to use a kind of electric current that periodically reverses direction, which is known as an alternating current (AC). In the kind of small, battery-powered motors we use around the home, a better solution is to add a component called a **commutator** to the ends of the coil. In its simplest form, the commutator is a metal ring divided into two separate halves and its job is to reverse the electric current in the coil each time the coil rotates through half a turn. One end of the coil is attached to each half of the commutator. The electric current from the battery connects to the motor's electric terminals. These feed electric power into the commutator through a pair of loose **connectors** called brushes, made either from pieces of graphite (soft carbon similar to pencil "lead") or thin lengths of springy metal, which (as the name suggests) "brush" against the commutator. With the commutator in place, when electricity flows through the circuit, the coil will rotate continually in the same direction.

A simple, experimental motor such as this isn't capable of making much power. We can increase the turning force (or **torque**) that the motor can create in three ways: either we can have a more powerful permanent magnet, or we can increase the electric current flowing through the wire, or we can make the coil so it has many "turns" (loops) of very thin wire instead of one "turn" of thick wire. In practice, a motor also has the permanent magnet curved in a circular shape so it almost touches the coil of wire that rotates inside it. The closer together the magnet and the coil, the greater the force the motor can produce.

Universal Motors

Although we've described a number of different parts, you can think of a motor as having just two essential components:

- There's a permanent magnet (or magnets) around the edge of the motor case that remains static, so it's called the stator of a motor.
- Inside the stator, there's the coil, mounted on an axle that spins around at high speed—and this is called the **rotor**. The rotor also includes the commutator.

In ordinary DC motors, like the ones we've just considered, the rotor spins inside the stator. The rotor is a coil connected to the electric power supply and the stator is a permanent magnet. Motors like this are great for battery-powered toys (things like electric trains, radio-controlled cars, or electric shavers), but you don't find them in many household appliances. Small electric appliances (things like coffee grinders or electric food blenders) tend to use what are called universal motors, which can be powered by either AC or DC. Unlike a simple DC motor, a universal motor has an electromagnet, instead of a permanent magnet, and it takes its power from the DC or AC power you feed in:

- When you feed in DC, the electromagnet works like a conventional permanent magnet and produces a magnetic field that's always pointing in the same direction. The commutator reverses the coil current every time the coil flips over, just like in a simple DC motor, so the coil always spins in the same direction.
- When you feed in AC, however, the current flowing through the electromagnet and the current flowing through the coil *both* reverse, exactly in step, so the force on the coil is always in the same direction and the motor always spins either clockwise or counter-clockwise. What about the commutator? The frequency of the current changes much faster than the motor rotates and, because the field and the current are always in step, it doesn't actually matter what position the commutator is in at any given moment.

Other Kinds of Electric Motors

Large AC motors work in a slightly different way again: they pass alternating current through opposing pairs of magnets to create a rotating magnetic field, which "induces" a magnetic field in the motor's rotor, causing it to spin around. If you take one of these induction motors and "unwrap" it, so the stator is effectively laid out into a long continuous track, the rotor can roll along it in a straight line. This ingenious design is known as a linear motor, and you'll find it in such things as factory machines and floating "maglev" (**magnetic levitation**) railroads.

Another interesting design is the brushless DC (BLDC) motor. The stator and rotor effectively swap over, with multiple iron coils static at the center and the permanent magnet rotating around them, and the commutator and brushes are replaced by an electronic circuit. Stepper motors, which turn around through precisely controlled angles, are a variation of brushless DC motors.

I. Answer the following questions based on reading passage 1

1.What makes the wire jump when you connect the two ends of the wire to a battery?

2.Who was the first scientist who discovered the link between electricity, magnetism, and movement?

3. Why is it suggested to add a commutator to the ends of a coil?

4.What are the essential parts of a motor?

II. Decide if the following statements about reading passage1 are true or false

1.Two magnets placed near one another always attract.

2. Only some motors have a stator.

3. In ordinary DC motors the rotor spins outside the stator.

4.The current flows in opposite directions in the two wires of a loop.

III. Fill in the blank with the proper word

axle-permanent-vertical-rotate-tangled –torque-supposed-flipped over

1. The accident has not done any……………….. damage.
2. The car hit a tree and ………………….
3.When you're standing up, you're ……………., as opposed to when you lie down in a horizontal position on the couch.
4. ……………… electrical wires and cables are dangerous.
5. The position of the ………….. can be altered so that the wheel revolves at any angle without the direction of its revolution being affected.
6. Stay well away from the helicopter when its blades start to ……………….
7. …………is a force that causes something to spin around a central point such as an axle.
8. I knew very well that the problem was more complex than he …………….

IV. Fill in the blanks with words from reading passage1

1. A shoe for a horse formed of a narrow band of iron in the form of an extended circular arc and secured to the hoof with nails: ……………
2. It is the stationary portion of an electric generator or motor, especially of an induction motor: ……………
3. A device used for starting the engine of a vehicle: …………..
4. To take off the paper, plastic, etc. that covers or protects something: …………

V. Fill in the blanks with the best derivation of the words given

Rotate

1.The Earth…………….. round the sun.

2. He has written an article about the daily ………….. of the earth upon its axis.

3. He fired up the engine and the ………………began to whirl.

Connect

1. She works in a factory that makes small electrical …………….. .

2. The relationships, the …………… between the elements, are of meaning in quantum mechanics.

3. The electrodes ……………… to a recording device.

Resonate

1. MR is the abbreviation of magnetic................ .

2. In a PEM, a piece of crystalline quartz is electronically excited to....................at a frequency determined by its shape and crystal orientation.

3. All atomic clocks measure time in terms of the natural.............. frequencies of various atoms and molecules.

Reading Passage 2

William Sturgeon, (born May 22, 1783, Whittington, Lancashire, Eng.—died Dec. 4, 1850, Prestwich, Lancashire), English electrical engineer who devised the first electromagnet capable of supporting more than its own weight. This device led to the invention of the telegraph, the electric motor, and numerous other devices basic to modern technology.

Sturgeon, self-educated in electrical phenomena and natural science, spent much time lecturing and conducting electrical experiments. In 1824 he became lecturer in science at the Royal Military College, Addiscombe, Surrey, and the following year he exhibited his first electromagnet. The 7-ounce (200-gram) magnet was able to support 9 pounds (4 kilograms) of iron using the current from a single cell. Sturgeon built an electric motor in 1832 and invented the commutator, an integral part of most modern electric motors. In 1836, the year he founded the monthly journal *Annals of Electricity,* he invented the first suspended coil galvanometer, a device for measuring current. He also improved the voltaic battery and worked on the theory of thermoelectricity. From more than 500 kite observations he established that in serene weather the atmosphere is invariably charged positively with respect to the Earth, becoming more positive with increasing altitude.

Answer the following questions based on reading passage 2

1.What is the significance of the electromagnet devised by Sturgeon?

2. What does a galvanometer do?

3. What did Sturgeon discover about atmosphere?

UNIT SEVEN

Vocabulary: pronunciation, definition and example

Agricultural: /ˌæɡrəˈkʌltʃərəl/ relating to the science or practice of farming
John is an agricultural worker.

Alternate: /ˈɔltərnət/ (of one or more things) available as another possibility or choice
Solar power is a good alternate for fossil fuels.

Barrage: /bəˈrɑʒ/ an artificial barrier across a river or estuary to prevent flooding, aid irrigation or navigation, or to generate electricity by tidal power
*They are considering a tidal barrage built across the Severn estuary***.**

Biofuel: /ˈbaɪoʊˌfyuəl/ a fuel derived immediately from living matter
Substituting five per cent of fossil fuels with biofuels could lead to around one million tonnes of carbon saving by 2010.

Combustion: /kəmˈbʌstʃən/ the process of burning something
Twenty-five percent of total worldwide emissions come from fossil fuel combustion.

Crucial: /ˈkruʃl/ of great importance
If you want to lose weight, it is crucial to maintain low insulin levels.

Desalination: /ˌdiˌsæləˈneɪʃn/ the process of removing salt from seawater
*The water supply of this island comes from desalination plants***.**

Diurnal: /daɪˈərnl/ of or during the day
Some areas, such as the Gulf of Mexico, have only one high and one low tide each day. This is called a diurnal tide.

Extract: /ˈɛkstrækt/ obtain (a substance or resource) from something by a special method
Lead was extracted from the copper.

Harness: /ˈhɑrnəs/ control and make use of (natural resources), especially to produce energy
They are trying to harness solar energy.

Gravitational: /ˌgrævəˈteɪʃənl/ relating to movement towards a centre of gravity
This planet is under the gravitational influence of its outward neighbour: Jupiter.

Negate: /nɪˈgeɪt/ make ineffective; nullify
*Alcohol negates the effects of the drug***.**

Pellet: /ˈpɛlət/ a small, rounded, compressed mass of a substance
Pellet fuels (or pellets) are biofuels made from compressed organic matter or biomass.

Viable: /ˈvaɪəbl/ capable of working successfully; feasible
Solar power will become a viable alternative to fossil fuels.

Reading Passage 1

Top 10 Renewable Energy Sources

There are many sources of energy that are renewable and considered to be environmentally friendly and **harness** natural processes. These sources of energy provide an **alternate** 'cleaner' source of energy, helping to **negate** the effects of certain forms of pollution. All of these power generation techniques can be described as renewable since they are not depleting any resource to create the energy. While there are many large-scale renewable energy projects and production, renewable technologies are also suited to small off-grid applications, sometimes in rural and remote areas, where energy is often **crucial** in human development.

Tidal Power

Tidal energy can be generated in two ways, tidal stream generators or by **barrage** generation. The power created though tidal generators is generally more environmentally friendly and causes less impact on established ecosystems. Similar to a wind turbine, many tidal stream generators rotate underwater and is driven by the swiftly moving dense water. Although not yet widely used, tidal power has potential for future electricity generation. Tides are more predictable than wind energy and solar power. Tidal power is the only form of energy which derives directly from the relative motions of the Earth–Moon system, and to a lesser extent from the Earth–Sun system. The tidal forces produced by the Moon and Sun, in combination with Earth's rotation, are responsible for the generation of the tides.

Wave Power

Wave power is the transport of energy by ocean surface waves, and the capture of that energy to do useful work — for example for electricity generation, water **desalination**, or the pumping of water (into reservoirs). Wave energy can be difficult to harness due to the unpredictability of the ocean and wave direction. Wave farms have been created and are in use in Europe, using floating Pelamis Wave Energy converters. Most wave power systems include the use of a floating buoyed device and generate energy through a snaking motion, or by mechanical movement from the waves peaks and troughs. Though often co-mingled, wave power is distinct from the **diurnal** flux of tidal power and the steady gyre of ocean currents. Wave power generation is not currently a widely employed commercial technology although there have been attempts at using it since at least 1890.

Solar Power

Photovoltaic (PV) Solar power is harnessing the suns energy to produce electricity. One of the fastest growing energy sources, new technologies are developing at a rapid pace. Solar cells are becoming more efficient, transportable and even flexible, allowing for easy installation. PV has mainly been used to power small and medium-sized applications, from the calculator powered by a single solar cell to off-grid homes powered by a photovoltaic array.

Wind Power

Wind power is the conversion of wind energy by wind turbines into a useful form, such as electricity or mechanical energy. Large-scale wind farms are typically connected to the local power transmission network with small turbines used to provide electricity to isolated areas. Residential units are entering production and are capable of powering large appliances to entire houses depending on the size. Wind farms installed on **agricultural** land or grazing areas, have one of the lowest environmental impacts of all energy sources. Although wind produces only about 1.5% of worldwide electricity use, it is growing rapidly, having doubled in the three years between 2005 and 2008. In several countries it has achieved relatively high levels of penetration, accounting for approximately 19% of electricity production in Denmark, 11% in Spain and Portugal, and 7% in Germany and the Republic of Ireland in 2008. Wind energy has historically been used directly to propel sailing ships or converted into mechanical energy for pumping water or grinding grain, but the principal application of wind power today is the generation of electricity.

Hydroelectricity

Hydroelectricity is electricity generated by hydropower, i.e., the production of power through use of the **gravitational** force of falling or flowing water. It is the most widely used form of renewable energy. Once a hydroelectric complex is constructed, the project produces no direct waste. Small scale hydro or micro-hydro power has been an increasingly popular alternative energy source, especially in remote areas where other power sources are not **viable**. Small scale hydro power systems can be installed in small rivers or streams with little or no discernible environmental effect or disruption to fish migration. Most small scale hydro power systems make no use of a dam or major water diversion, but rather use water wheels to generate energy. This was approximately 19% of the world's electricity (up from 16% in 2003), and accounted for over

63% of electricity from renewable sources. While many hydroelectric projects supply public electricity networks, some are created to serve specific industrial enterprises.

Radiant Energy

This natural energy can perform the same wonders as ordinary electricity at less than 1% of the cost. It does not behave exactly like electricity, however, which has contributed to the scientific community's misunderstanding of it. The Methernitha Community in Switzerland currently has 5 or 6 working models of fuelless, self-running devices that tap this energy. Nikola Tesla's magnifying transmitter, T. Henry Moray's radiant energy device, Edwin Gray's EMA motor, and Paul Baumann's Testatika machine all run on radiant energy. This natural energy form can be gathered directly from the environment or **extracted** from ordinary electricity by the method called fractionation. One of the earliest wireless telephones to be based on radiant energy was invented by Nikola Tesla. The device used transmitters and receivers whose resonances were tuned to the same frequency, allowing communication between them.

Geothermal Power

Geothermal energy is a very powerful and efficient way to extract a renewable energy from the earth through natural processes. This can be performed on a small scale to provide heat for a residential unit (a geothermal heat pump), or on a very large scale for energy production through a geothermal power plant. It has been used for space heating and bathing since ancient roman times, but is now better known for generating electricity. Geothermal power is cost effective, reliable, and environmentally friendly, but has previously been geographically limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for direct applications such as home heating. The largest group of geothermal power plants in the world is located at The Geysers, a geothermal field in California, United States. As of 2004, five countries (El Salvador, Kenya, the Philippines, Iceland, and Costa Rica) generate more than 15% of their electricity from geothermal sources.

Biomass

Biomass, as a renewable energy source, refers to living and recently dead biological material that can be used as fuel or for industrial production. In this context, biomass refers to plant matter grown to generate electricity or produce for example trash such as dead trees and branches, yard clippings and wood chips **biofuel**, and it also includes plant or animal matter used for production of fibers, chemicals or heat. Biomass may also include biodegradable wastes that can be burnt as fuel. Industrial biomass can be grown from numerous types of plants, including miscanthus, switchgrass, hemp, corn, poplar, willow, sorghum, sugarcane, and a variety of tree species, ranging from eucalyptus to oil palm (palm oil). The particular plant used is usually not important to the end products, but it does affect the processing of the raw material. Production of biomass is a growing industry as interest in sustainable fuel sources is growing. The existing commercial biomass power generating industry in the United States produces about 0.5 percent of the U.S. electricity supply.

Compressed Natural Gas

Compressed Natural Gas (CNG) is a fossil fuel substitute for gasoline, diesel, or propane fuel. Although its **combustion** does produce greenhouse gases, it is a more environmentally clean alternative to those fuels, and it is much safer than other fuels in the event of a spill (natural gas is lighter than air, and disperses quickly when released). CNG is used in traditional gasoline internal combustion engine cars that have been converted into bi-fuel vehicles (gasoline/CNG). Natural gas vehicles are increasingly used in Europe and South America due to rising gasoline prices. Italy currently has the largest number of CNG vehicles in Europe and is the 4th country in the world for number of CNG-powered vehicles in circulation.

Nuclear Power

An atom's nucleus can be split apart. When this is done, a tremendous amount of energy is released. The energy is both heat and light energy. Einstein said that a very small amount of matter contains a very large amount of energy. This energy, when let out slowly, can be harnessed to generate electricity. When it is let out all at once, it can make a tremendous explosion in an atomic bomb.

A nuclear power plant uses uranium as a "fuel". Uranium is an element that is dug out of the ground many places around the world. It is processed into tiny **pellets** that are loaded into very long rods that are put into the power plant's reactor.

The word fission means to split apart. Inside the reactor of an atomic power plant, uranium atoms are split apart in a controlled chain reaction.

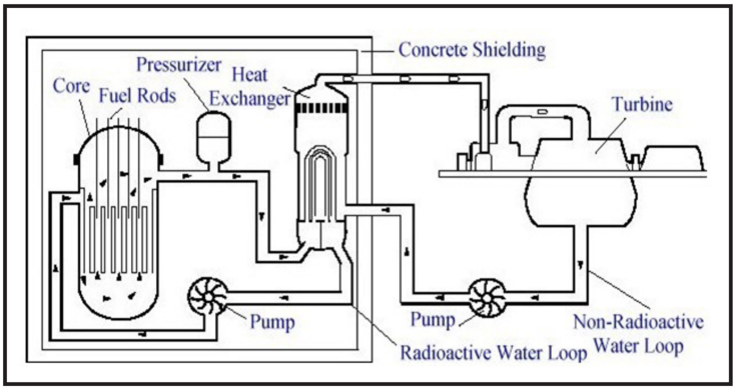
In a chain reaction, particles released by the splitting of the atom go off and strike other uranium atoms splitting those. Those particles given off split still other atoms in a chain reaction. In nuclear power plants, control rods are used to keep the splitting regulated so it doesn't go too fast.

If the reaction is not controlled, you could have an atomic bomb. But in atomic bombs, almost pure pieces of the element Uranium-235 or Plutonium, of a precise mass and shape, must be brought together and held together, with great force. These conditions are not present in a nuclear reactor.

The reaction also creates radioactive material. This material could hurt people if released, so it is kept in a solid form. A very strong concrete dome is designed to keep this material inside if an accident happens.

This chain reaction gives off heat energy. This heat energy is used to boil water in the core of the reactor. So, instead of burning a fuel, nuclear power plants use the chain reaction of atoms splitting to change the energy of atoms into heat energy.

This water from around the nuclear core is sent to another section of the power plant. Here, in the heat exchanger, it heats another set of pipes filled with water to make steam. The steam in this second set of pipes turns a turbine to generate electricity. Below is a cross section of the inside of a typical nuclear power plant.



I. Answer the following questions based on reading passage 1

1. Why is tidal power preferred over wind energy?

2. What is the name of energy produced from trash such as dead trees and branches?

3. What does a dome do in a nuclear power plant?

4. Why are control rods used in nuclear power plants?

II. Decide if the following statements about reading passage1 are true or false

1. Nowadays tidal power produces a great deal of our electricity.
2. Geothermal energy is extracted only through natural processes.
3. CNG is not 100% clean.
4. Renewable energies can help us get rid of the effects of certain forms of pollution.

III. Fill in the blank with the proper word

diurnal-harness-transmitters-biofuel-crucial-cumbustion-desalination-extracted-

1.The system would have produced 3.5 megawatts - the five turbines being designed to …………..tidal energy and turn it into electricity.
2. In this factory, oil is………….from sunflower seeds.

3. Vitamins are ...………....for maintaining good health.

4. …………….. may occur at high temperatures.

5. The researchers used quartz crystals, like the wave ………….. in televisions and radios, which vibrate in an electrical field.

6. . ...……….... is a process that removes minerals from saline water.

7. In order to be considered a ...……………..... the fuel must contain over 80 percent renewable materials.

8. An area has a ……………tidal cycle if it experiences one high and one low tide every lunar day.

IV. Fill in the blanks with words from reading passage1

1.They are small particles typically created by compressing an original material:.……

2. The energy of electromagnetic and gravitational radiation:…..

3. It is a type of low-head, diversion dam which consists of a number of large gates that can be opened or closed to control the amount of water passing:…..

4. A biological community of interacting organisms and their physical environment:.…..

V. Fill in the blanks with the best derivation of the words given

Renew

1. There has been a shift away from fossil fuels to ……..……energies.

2. A generator was replaced and filters were …………**.**

3**.**Recently there's been a …………….. of interest in mountain climbing.

Environ

1. All renewable energy sources are ………………friendly , but which one is the best for our …………..?

2. I don’t want my children to be ………………..by bad influences.

Pollute

1. The explosion ………………. the town with dioxin.

2. The level of ………………. in the air is rising.

3. The…………...river is a threat to the citizens’ health.

Reading Passage 2

James Clerk Maxwell, (born June 13, 1831, Edinburgh, Scotland—died November 5, 1879, Cambridge, Cambridgeshire, England) Scottish physicist best known for his formulation of electromagnetic theory. He is regarded by most modern physicists as the scientist of the 19th century who had the greatest influence on 20th-century physics, and he is ranked with Sir Isaac Newton and Albert Einstein for the fundamental nature of his contributions. In 1931, on the 100th anniversary of Maxwell's birth, Einstein described the change in the conception of reality in physics that resulted from Maxwell's work as "the most profound and the most fruitful that physics has experienced since the time of Newton."

The concept of electromagnetic radiation originated with Maxwell, and his field equations, based on Michael Faraday's observations of the electric and magnetic lines of force, paved the way for Einstein's special theory of relativity, which established the equivalence of mass and energy. Maxwell's ideas also ushered in the other major innovation of 20th-century physics, the quantum theory. His description of electromagnetic radiation led to the development (according to classical theory) of the ultimately unsatisfactory law of heat radiation, which prompted Max Planck's formulation of the quantum hypothesis—i.e., the theory that radiant-heat energy is emitted only in finite amounts, or quanta. The interaction between electromagnetic radiation and matter, integral to Planck's hypothesis, in turn has played a central role in the development of the theory of the structure of atoms and molecules.

Answer the following questions based on reading passage 2

1. How was the quantum theory developed?

2. On whose observations are Maxwell's equations based?

3.Why is Maxwell ranked with Newton and Einstein?

UNIT EIGHT

Vocabulary: pronunciation, definition and example

Affix: /əˈfɪks/ stick, attach, or fasten (something) to something else

Affix the stamp to the envelope.

Capacitance: /kəˈpæsət̬əns/ the ability of a system to store an electric charge

The capacitance of a condenser or a circuit depends on its size and form and the voltage of the current that is charging it.

Capacitor: /kəˈpæsət̬ər/ a device used to store an electric charge, consisting of one or more pairs of conductors separated by an insulator

A capacitor is a passive two-terminal electrical component that stores electrical energy in an electric field.

Compose: /kəmˈpoʊz/ (of elements) constitute or make up (a whole, or a specified part of it)

Saturn's rings are composed primarily of water ice particles, and range in size from micrometers to meters.

Decouple: /diˈkʌpl/ make the interaction between (electrical components) so weak that there is little transfer of energy between them, especially to remove unwanted AC distortion or oscillations in circuits with a common power supply

This is a technique for decoupling the energy storage system voltage from the DC link voltage in AC electric drive systems.

Dielectric: /ˌdʌɪˈlɛktrɪk/ an insulator

The dielectric can be air, paper, plastic or anything else that does not conduct electricity and keeps the plates from touching each other.

Encapsulate: /ɪnˈkæpsəˌleɪt/ to enclose in or as if in a capsule

The semiconductor chip, the die pad, and the connection pads are encapsulated in a package body.

Frictional: /ˈfrɪkʃ(ə)n(ə)l/ of or produced by the action of one surface or object rubbing against or moving over another

Air resistance is a type of frictional force.

Leakage: /ˈlikɪdʒ/ the gradual escape of an electric charge or current, or magnetic flux

Check for voltage leakage from every possible source.

Oscillator: /ˈɑsəˌleɪt̬ər/ a device for producing alternating current; especially : a radio-frequency or audio-frequency generator

Passive components are capacitors, resistors, connectors, filters, inductors, and oscillators.

Phenomena: /fəˈnɑmənə/ plural form of phenomenon

Phenomenon: /fəˈnɑməˌnɑn/ an observable fact or event
Lightning is one of the most fascinating yet beautiful natural weather phenomena that we see here on Earth.

Solder: /ˈsɑdər/ join
Wires are soldered onto the circuit board.

Static: /ˈstæt̮ɪk/ (of an electric charge) having gathered on or in an object that cannot conduct a current
These electrons are then accelerated by a static electric field towards a fluorescent screen.

Sufficient: /səˈfɪʃnt/ enough; adequate
He had a small private income which was sufficient for her needs.

Transparent: /trænsˈpɛrənt/ (of a material or article) allowing light to pass through so that objects behind can be distinctly seen
The projection screen is fabricated of a substantially transparent material, such as glass or plastic.

Tune: /tun/ adjust (a receiver circuit such as a radio or television) to the frequency of the required signal:

The radio was tuned to IRIB.

Reading Passage 1

Capacitor and Capacitance

We are now all very much familiar with the fact that **static** charges can be generated very easily, if we can somehow apply **sufficient frictional** force between two bodies under consideration. For example, pulling a **transparent** tape off a roll results in the separation of small amounts of positive and negative charge, which can be accumulated separately within the two bodies. This particular **phenomena** gave rise to the concept of capacitors, which is simply a device for charge storage.

Capacitor is a passive element that stores electric charge statistically and temporarily as an static electric field. It is **composed** of two parallel conducting plates separated by non-conducting region that is called **dielectric**, such as vacuum, ceramic, air, aluminum, etc. The **capacitance** formula of the capacitor is represented by, $C = \frac{\epsilon A}{d}$C is the capacitance that is proportional to the area of the two conducting plates (A) and proportional with the permittivity ε of the dielectric medium. The capacitance decreases with the distance between plates (d). We get the greatest capacitance with a large area of plates separated by a small distance and located in a high permittivity material. The standard unit of capacitance is Farad, most commonly it can be found in micro-farads, pico-farads and nano-farads.

General Uses of Capacitors

1. Smoothing, especially in power supply applications which required converting the signal from AC to DC.

2. Storing Energy.

3. Signal **decoupling** and coupling as a capacitor coupling that blocks DC current and allow AC current to pass in circuits.

4. Tuning, as in radio systems by connecting them to LC **oscillator** and for tuning to the desired frequency.

5. Timing, due to the fixed charging and discharging time of capacitors.

6. For electrical power factor correction and many more applications.

Charging a Capacitor

Capacitors are mainly categorized on the basis of dielectric used in them. During choosing a specific type of capacitors for a specific application, there are numbers of factors that get considered. The value of capacitance is one of the vital factors to be considered. Not only this, many other factors like, operating voltage, allowable tolerance stability**,** **leakage** resistance, size and prices are also very important factors to be considered during choosing specific type of capacitors.

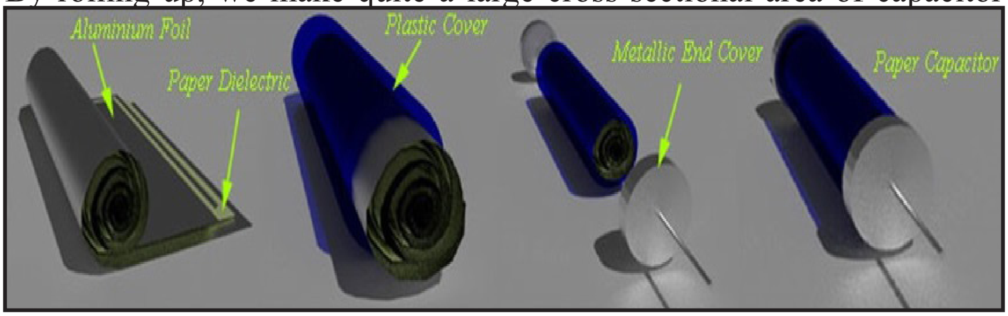
We know that capacitance of a capacitor is given by, $C = \frac{\epsilon A}{d}$Hence, it is cleared that, by varying ε, A or d we can easily change the value of C. If we require higher value of capacitance (C) we have to increase the cross-sectional area of dielectric or we have to reduce the distance of separation or we have to use dielectric material with stronger permittivity. If we go only for the increasing area of cross-section, the rise of the capacitor may become quite large; which may not be practically acceptable. Again if we reduce only the distance of separation, the thickness of dielectric becomes very thin.

Types of Capacitors

The various types of capacitors have been developed to overcome these problems in a number of ways.

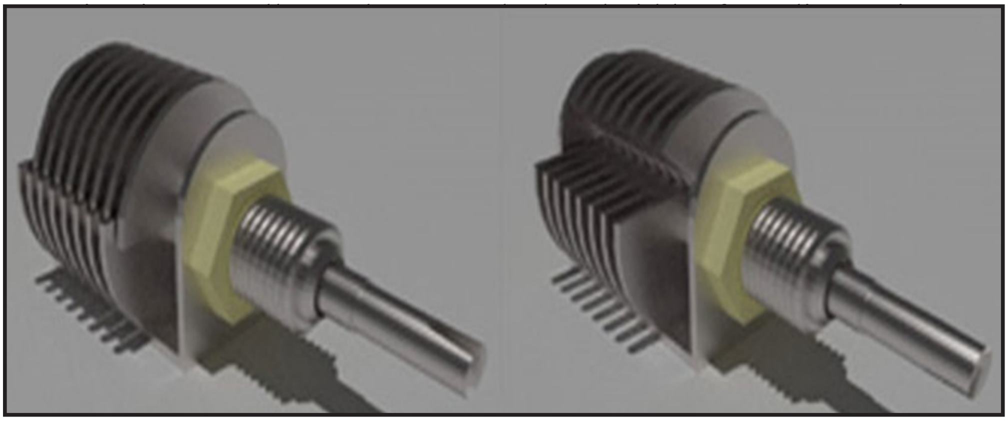
Paper Capacitor

It is one of the simple forms of capacitors. Here, a waxed paper is sandwiched between two aluminium foils. Process of making this capacitor is quite simple. Take place of aluminium foil. Cover this foil with a waxed paper. Now, cover this waxed paper with another aluminium foil. Then roll up this whole thing as a cylinder. Put two metal caps at both ends of roll. This whole assembly is then **encapsulated** in a case. By rolling up, we make quite a large cross-sectional area of capacitor



Air Capacitor

There are two sets of parallel plates. One set of plates is fixed and another set of plates is movable. When the knob connected with the capacitor is rotated, the movable set of plates rotates and overlapping area as between fixed and movable plates vary. This causes variation in effective cross-sectional areas of the capacitor. Consequently, the capacitance varies when one rotates the knob attached to the air capacitor. This type of



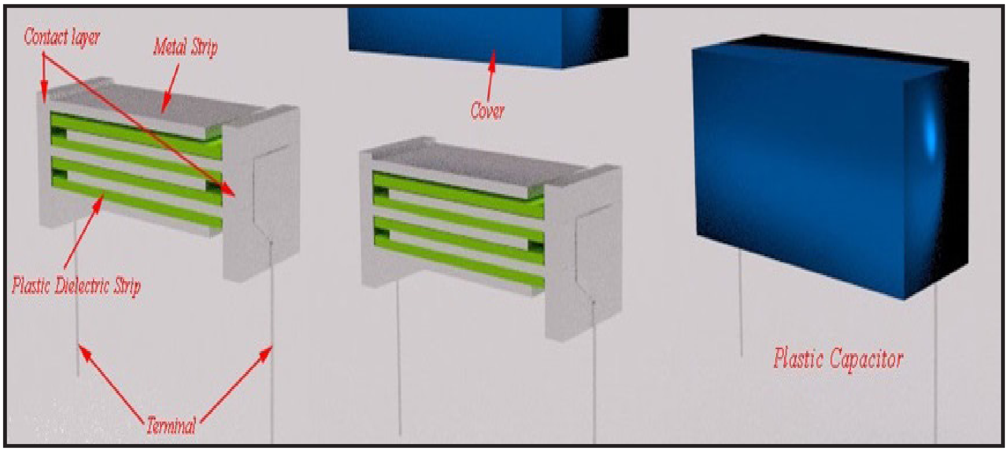
Plastic Capacitor

When various plastic materials are used as dielectric material, the capacitors are said to be plastic capacitors. The plastic material may be of polyester, polystyrene, polycarbonate or poly propylene. Each of these materials has slightly different electrical characteristics, which can be used to advantage, depending upon the proposed application.

This type of capacitors is constructional, more or less same as paper capacitor. That means, a thin sheet one of the earlier mentioned plastic dielectrics, is kept between two aluminium foils. That means, here the flexible thin plastic sheet is used as dielectric instead of waxed paper. Here, the plastic sheet covered by aluminium foil from two sides, is first rolled up, then fitted with metal end caps, and then the whole assembly is encapsulated in a case.

Plastic Film Capacitor

Plastic capacitor can be made also in form of film capacitor. Here, thin strips or films of plastic are kept inside metallic strips. Each metallic strip is connected to side metallic contact layer alternatively.That means, if one metallic strip is connected to left side contact layer, then the very next is connected to right side contact layer. And there are plastic films in between these metallic strips. The terminals of this type of capacitors

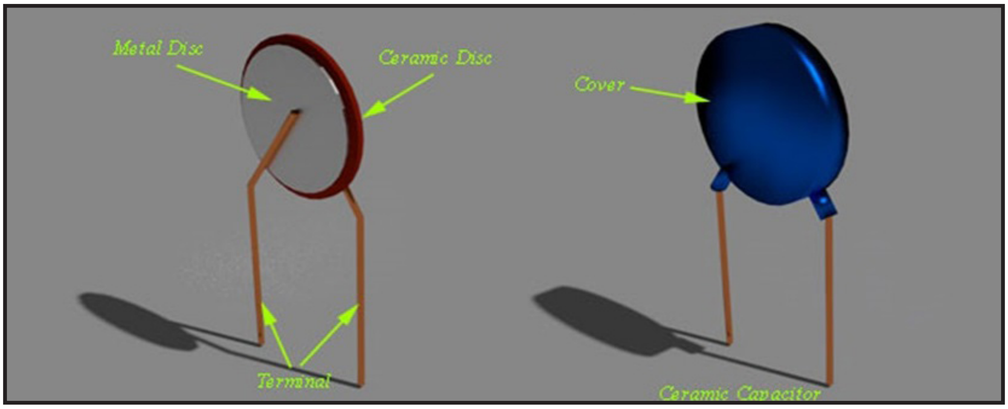


Silvered Mica Capacitor

A silvered mica capacitor is very accurate and reliable capacitor. This type of capacitors has very low tolerance. But on the other hand, cost of this capacitor is quite higher compared to other available capacitors in the market. But this high cost capacitor can easily be compensated by its high quality and performance. A small ceramic disc or cylinder is coated by silver **compound**. Here, electrical terminal is **affixed** on the silver coating and the whole assembly is encapsulated in a casing.

Ceramic Capacitor

Construction of ceramic capacitor is quite simple. Here, one thin ceramic disc is placed between two metal discs and terminals are **soldered** to the metal discs. Whole assembly is coated with insulated protection coating as shown in the figure below.



Mixed Dielectric Capacitor

The way of constructing this capacitor is same as paper capacitor. Here, instead of moving waxed paper as dielectric, paper impregnated with polyester is used as dielectric between two conductive aluminium foils.

Electrolyte Capacitor

Very large value of capacitance can be achieved by this type of capacitor. But working voltage level of this electrolyte capacitor is low and it also suffers from high leakage current. The main disadvantage of this capacitor is that, due to the use of electrolyte, the capacitor is polarized. The polarities are marked against the terminals with + and – sign and the capacitor must be connected to the circuit in proper polarity.

I. Answer the following questions based on reading passage 1

1. How can we get the greatest capacitance?

2. What factors should be considered for choosing a specific type

of capacitor?

3. What are the advantage and disadvantage of silvered mica capacitor?

4. What is the standard unit of capacitance?

II. Decide if the following statements about reading passage1 are true or false

1.Paper capacitors are the most accurate.

2.Capacitor is a passive element that stores electric charge statistically and permanently as an static electric field.

3.Plastic materials used in plastic capacitors have exactly the same electrical characteristics.

4.The value of capacitance is the only vital factor to be considered.

III. Fill in the blank with the proper word

frictional-dielectric-oscillator-encapsulated-phenomena-leakage-static-sufficient-

1.A condenser is a device composed of two or more conductors insulated from each other by a medium called the……………..

2.Her explanation was not ……………….to satisfy the police.

3.Sometimes explanations of physical ……………… involve mathematical facts.

4.…………… electricity is an imbalance of electric charges within or on the surface of a material.

5.The direction of the ……………… force always opposes the direction of motion.

6.The pilot was ………………… in the cockpit.

7.Ac power is converted to a high-voltage DC current, which an ……………. or resonator outputs as an alternating current.

8.Current ………………. and direct coupling when an energized metal active electrode tip comes in contact with another metal instrument or object potentially can damage or cause injury to the device or tissues.

IV. Fill in the blanks with words from the passage1

1.A thing that is composed of two or more separate elements; a mixture: ……

2.The action or method of storing something for future use: ………...

3.A solid geometrical figure with straight parallel sides and a circular or oval cross section: ……….

4.The property of having poles or being polar: ………...

V. Fill in the blanks with the best derivation of the words given

Friction

1.Students might enjoy researching some of the ways in which ……………forces are minimized in such sports.

2.Any moving object on Earth experiences a force, called ………… which opposes its motion.

Separate

1.Marta and his brother were…………….. by the war.

2.The phenomenon of static electricity requires a ……………..of positive and negative charges.

3.The students entered the class…………….

Suffice

1.Missing data complicates the interpretation, but it ………… as an example.

2.We don't have ………………. staff and resources to do our job properly.

1. 3.We have a …………………. large working force in Iran.

Reading Passage 2

Nikola Tesla**,** (born July 9/10, 1856, Smiljan, Austrian Empire [now in Croatia]—died January 7, 1943, New York, New York, U.S.), was a Serbian-American inventor, electrical engineer, mechanical engineer, physicist, and futurist who is best known for his contributions to the design of the modern alternating current (AC) electricity supply system. Tesla gained experience in telephony and electrical engineering before emigrating to the United States in 1884 to work for Thomas Edison in New York City. He soon struck out on his own with financial backers, setting up laboratories and companies to develop a range of electrical devices. His patented AC induction motor and transformer were licensed by George Westinghouse, who also hired Tesla for a short time as a consultant. His work in the formative years of electric-power development was involved in a corporate alternating current/direct current "War of Currents" as well as various patent battles.

Tesla went on to pursue his ideas of wireless lighting and electricity distribution in his high-voltage, high-frequency power experiments in New York and Colorado Springs and made early (1893) pronouncements on the possibility of wireless communication with his devices. He tried to put these ideas to practical use in an ill-fated attempt at intercontinental wireless transmission, his unfinished Wardenclyffe Tower project. In his lab, he also conducted a range of experiments with mechanical oscillators/generators, electrical discharge tubes, and early X-ray imaging. He also built a wireless controlled boat, one of the first ever exhibited.

Tesla was renowned for his achievements and showmanship, eventually earning him a reputation in popular culture as an archetypal "mad scientist". His patents earned him a considerable amount of money, much of which was used to finance his own projects with varying degrees of success. He lived most of his life in a series of New York hotels through his retirement. Tesla died on 7 January 1943 in New York City. His work fell into relative obscurity after his death, but in 1960, the General Conference on Weights and Measures named the SI unit of magnetic flux density the tesla in his honor.

Answer the following questions based on reading passage 2

1.What did the General Conference on Weights and Measures do in Tesla’s honor?

2.What is Tesla best known for?

3.What are some of Tesla’s inventions?

UNIT NINE

Vocabulary: pronunciation, definition and example

Affordable: /əˈfɔrdəbl/ inexpensive
Most people in Europe have Internet access at an affordable price.

Amplify: /ˈæmpləˌfaɪ/ increase the amplitude of (an electrical signal or other oscillation)
The manufacturers have developed a system of amplifying the radio signal.

Binary: /ˈbaɪnɛri/ relating to, composed of, or involving two things
Binary states are often represented as 1 and 0 in computer science.

Calculation: /ˌkælkyəˈleɪʃn/ a mathematical determination of the amount or number of something
The computer can do millions of calculations each second.

Capacitor: /kəˈpæsət̬ər/ a device used to store an electric charge, consisting of one or more pairs of conductors separated by an insulator
The devices use two external polarised electrolytic capacitors that can also be reconfigured to double the supply voltage.

Diameter: /daɪˈæmət̬ər/ a straight line passing from side to side through

the centre of a body or figure, especially a circle or sphere
Dig a hole that's two feet deep and three feet in diameter.

Faucet: /ˈfɔsət/ a tap
Don't forget to turn off the faucet.

Hearing aid: A small amplifying device which fits on the ear, worn by a partially deaf person
She did wear a big hearing aid that delivered highly amplified sound to her left ear.

Impurity: /ɪmˈpyʊrət̬i/ a trace element deliberately added to a semiconductor; a dopant
Recent research has discovered that a semiconductor can be made magnetic by doping it with an impurity such as Mn.

Integrated circuit: an electronic circuit formed on a small piece of semiconducting material, which performs the same function as a larger circuit made from discrete components
Nanotube connectors as thin as 1.2 nanometers are theoretically capable of supplying sufficiently large electric currents to integrated circuits.

Isolated: /ˈaɪsəˌleɪt̬əd/ having minimal contact or little in common with others
First contacts with completely isolated tribes are rare these days, but they still happen.

Trickle: /ˈtrɪkl/ A small flow of liquid

A small trickle of blood flowed from the corner of his mouth down his chin.

Reading Passage 1

What Exactly is a Transistor?

Transistors are devices that control the movement of electrons, and consequently, electricity. They work something like a water **faucet --** not only do they start and stop the flow of a current, but they also control the amount of the current. With electricity, transistors can both switch or **amplify** electronic signals, letting you control current moving through a circuit board with precision.

The transistors made at Bell Labs were initially made from the element germanium. Scientists there knew pure germanium was a good insulator. But adding **impurities** (a process called doping) changed the germanium into a weak conductor, or semiconductor. Semiconductors are materials that have properties in-between insulators and conductors, allowing electrical conductivity in varying degrees.

The timing of the invention of transistors was no accident. To work properly, transistors require pure semiconductor materials. It just so happened that right after World War II, improvements in germanium refinement, as well as advances in doping, made germanium suitable for semiconductor applications.

Depending on the element used for doping, the resulting germanium layer was either negative type (N-type), or positive type (P-type). In an N-type layer, the doping element added electrons to the germanium, making it easier for electrons to surge out. Conversely, in a P-type layer, specific doping elements caused the germanium to lose electrons, thus, electrons from adjacent materials flowed towards it.

Place the N-type and P-type adjacent to each other and you create a P-N diode. This diode allows an electrical current to flow, but in only one direction, a useful property in the construction of electronic circuits.

Full-fledged transistors were the next step. To create transistors, engineers layered doped germanium to make two layers back to back, in a configuration of either P-N-P or N-P-N. The point of contact was called a junction, thus the name junction transistor.

With an electrical current applied to the center layer (called the base), electrons will move from the N-type side to the P-type side. The initial small **trickle** acts as a switch that allows much larger current to flow. In an electric circuit, this means that transistors are acting as both a switch and an amplifier.

These days, in place of germanium, commercial electronics use silicon-based semiconductors, which are more reliable and more **affordable** than germanium-based transistors. But once the technology caught on, germanium transistors were in widespread use for more than 20 years.

Transistor Radios and the Electronics Revolution

Transistors work primarily as switches and amplifiers. Given those functions, it's no surprise that sound-related devices were the first commercial products to use transistors. In 1952, transistorized **hearing aids** hit the market. These were niche products, though, compared to transistor radios that emerged in 1954. Radios exposed manufacturers and consumers alike to the revolutionizing potential of transistors.

The function of transistors in radios is straightforward. Sounds are recorded through a microphone and turned into electrical signals. Those signals travel through a circuit, and the transistor amplifies the signal, which is subsequently much louder when it reaches a speaker.

Convincing manufacturers that this basic concept would work on mass-produced products, however, wasn't such a simple task. In 1954, transistors were proven but novel electronic components. Device manufacturers had been using vacuum tubes profitably for many years, so they were understandably leery about switching to transistors.

But Pat Haggerty, vice president at a company called Texas Instruments, was convinced that transistors were going to revolutionize the electronics industry. Texas Instruments used Bell Labs' breakthroughs in germanium transistors to develop a small, pocket-sized transistor radio, with the help of a small Indiana company named IDEA. Together, the two companies created a radio called the Regency TR-1, which was announced on Oct. 18, 1954.

From start to finish, the race to create the TR-1 required innovative new parts that would fit inside a pocket-sized case, which would be small enough to really capture the world's attention. The speaker, **capacitors**, and other components were created just for this project. The transistors, though, were what really made the project possible.

Texas Instruments devised processes for mass-producing transistors for their radios, and in the process, proved that transistors and their subsequent products could be affordable, more portable and more effective than vacuum tubes. Within a year, other companies, such as Emerson, General Electric and Raytheon, all began selling transistor-based products. The modern electronics boom had begun.

Transistors and the Computer Age

Without transistors, engineers might never have created amazingly small and power digital products.

Once mass-produced transistorized hearing aids and radios became realities, engineers realized that transistors would replace vacuum tubes in computers, too. One of the first pre-transistor computers, the famous ENIAC (Electronic Numerical Integrator and Computer) weighed 30 tons, thanks in part to its more than 17,000 vacuum tubes. It was obvious that transistors would completely change computer engineering and result in smaller machines.

Germanium transistors certainly helped start the computer age, but silicon transistors revolutionized computer design and spawned an entire industry in California's aptly-named Silicon Valley.

In 1954, George Teal, a scientist at Texas Instruments, created the first silicon transistor. Soon after, manufacturers developed methods for mass-producing silicon transistors, which were cheaper and more reliable than germanium-based transistors.

Silicon transistors worked wonderfully for computer production. With smart engineering, transistors helped computers power through huge numbers of **calculations** in a short time. The simple switch operation of transistors is what enables your computer to complete massively complex tasks. In a computer chip, transistors switch between two **binary** states -- 0 and 1. This is the language of computers. One computer chip can have millions of transistors continually switching, helping complete complex calculations.

In a computer chip, the transistors aren't **isolated**, individual components. They're part of what's called an **integrated** circuit (also known as a microchip), in which many transistors work in concert to help the computer complete calculations. An integrated circuit is one piece of semiconductor material loaded with transistors and other electronic components.

Computers use those currents in tandem with Boolean algebra to make simple decisions. With many transistors, a computer can make many simple decisions very quickly, and thus perform complex calculations very quickly, too.

Computers need millions or even billions of transistors to complete tasks. Thanks to the reliability and incredibly small size of individual transistors, which are much smaller than the **diameter** of a single human hair, engineers can pack an unfathomable number of transistors into a wide array of computer and computer-related products.

I. Answer the following questions based on reading passage 1

1. How was germanium changed into a semiconductor?

2. What is the function of transistors in radios ?

3. Why was is difficult to convince the manufacturers to use transistors?

4. What does ENIAC stand for?

II. Decide if the following statements about reading passage1 are true or false

1. Adding impurities does not change the conductivity of a transistor.
2. An N-P diode allows an electrical current to flow back and forth.
3. The first pocket-sized transistor radio was produced in Bell's Lab.
4. Transistors enable your computer to complete massively complex tasks.

III. Fill in the blank with the proper word

binary-amplifies-diameter-hearing aid-affordable-impurity-capacitor-integrated circuits

1.What is the ...………………. of the tree trunk?
2. Silicon is best known as the material used to make semiconductor computer chips with ………………….
3. Often the conducting properties of a semiconductor can be varied by adding an ………….. known as a dopant so that a semiconductor can be made to act like either an insulator or a conductor.
4. ………………. data is data whose unit can take on only two possible states.
5. All services of this hotel are offered at an……………..price.
6. A receiver ………………. the television signals.
7. A ……………….is also known as a condenser.
8. My grandma can't here very well. She has to wear a(n) …………….

IV. Fill in the blanks with words from reading passage1

1. A substance used to produce a desired electrical characteristic in a

semiconductor.: …

2. A sealed glass tube containing a near-vacuum which allows the free passage of electric current:………..

3. The chemical element of atomic number 32, a shiny grey semimetal:………

4. The part of mathematics in which letters and other general symbols are used to represent numbers and quantities in formulae and equations:………….

V. Fill in the blanks with the best derivation of the words given

Amplify

1. Hearing aids are electronic devices made up of a microphone, an …………., a loudspeaker and a battery.

2. This system reads out the chemical changes electronically, ……………. the electronic signal and further processes it.

How is a weak radio signal……..…?

Calculate

1. Can you………….…the volume of a cylinder?

2. According to experts' ..…..…..…..…...., that star will explode within two billion years.

3. By inventing the pocket…………….., he revolutionized personal computing.

Isolate

1. Certain patients must be……………… in a separate ward.

2. Forced ……………. always made the sociable child lonely.

3. He likes to ………………himself in his room.

Reading Passage 2

William B. Shockley, in full William Bradford Shockley (born Feb. 13, 1910, London, Eng.—died Aug. 12, 1989, Palo Alto, Calif., U.S.) American engineer and teacher, cowinner (with John Bardeen and Walter H. Brattain) of the Nobel Prize for Physics in 1956 for their development of the transistor, a device that largely replaced the bulkier and less-efficient vacuum tube and ushered in the age of microminiature electronics.

Shockley studied physics at the California Institute of Technology (B.S., 1932) and at the Massachusetts Institute of Technology (Ph.D., 1936). He joined the technical staff of the Bell Telephone Laboratories in 1936 and there began experiments with semiconductors that ultimately led to the invention and development of the transistor. During World War II, he served as director of research for the Antisubmarine Warfare Operations Research Group of the U.S. Navy.After the war, Shockley returned to Bell Telephone as director of its research program on solid-state physics. Working with Bardeen and Brattain, he resumed his attempts to use semiconductors as amplifiers and controllers of electronic signals. The three men invented the point-contact transistor in 1947 and a more effective device, the junction transistor, in 1948. Shockley was deputy director of the Weapons Systems Evaluation Group of the Department of Defense in 1954–55. He joined Beckman Instruments, Inc., to establish the Shockley Semiconductor Laboratory in 1955. In 1958 he became lecturer at Stanford University, California, and in 1963 he became the first Poniatoff professor of engineering science there (emeritus, 1974). He wrote *Electrons and Holes in Semiconductors* (1950).

Answer the following questions based on reading passage 2

1. Why did Shockley and his colleagues win Noble Prize?

2. What did Shockley do during the World War?

3.Who invented the point-contact transistor?

UNIT TEN

Vocabulary: pronunciation, definition and example

Accuracy: /ˈækyərəsi/ the degree to which the result of a measurement, calculation, or specification conforms to the correct value or a standard
The team is currently trying to improve the accuracy of these calculations, and to obtain similar accuracies for the intensity of the absorption lines.

Complications: /ˌkɑmpləˈkeɪʃn/ a circumstance that complicates something; a difficulty
In the history of fine watchmaking, perhaps the most mystical and precious complication of all has been the equation of time.

Coordination: /koʊˌɔrdnˈeɪʃn/ the organization of the different elements of a complex body or activity so as to enable them to work together effectively
An important managerial task is the control and coordination of activities.

Differential equation: an equation involving derivatives of a function or functions

He then wrote on algebraic functions, differential equations and complex analysis.

Feasible: /ˈfizəbl/ likely; probable
I think his explanation is actually feasible.

Implement: /ˈɪmpləmənt/ put (a decision, plan, agreement, etc.) into effect
The final part of the plan was never fully implemented.

Interdisciplinary: /ˌɪntərˈdɪsəpləˌnɛri/ relating to more than one branch of knowledge
Interdisciplinary research is the key to the study of health sciences, for example in studying optimal solutions to diseases.

Pneumatic: /nʊˈmæt̬ɪk/ containing or operated by air or gas under pressure
The machines with pneumatic loading are more efficient.

Principles: /ˈprɪnsəpl/ a general scientific theorem or law that has numerous special applications across a wide field
The ability to derive interesting conclusions from general principles comes earlier in physics than in other sciences.

Specify: /ˈspɛsəˌfaɪ/ identify clearly and definitely
Can you specify the cause of the argument?

Variable: /ˈvɛriəbl/ (of a quantity) able to assume different numerical values
A constant variable is the term for a variable that remains constant throughout an experiment, though other variables may change.

Vector: /ˈvɛktər/a quantity having direction as well as magnitude, especially as determining the position of one point in space relative to

another
A vector quantity has magnitude and direction.

Reading Passage 1

Control Engineering

Control system engineering is the branch of engineering which deals with the **principles** of control theory to design a system which gives desired behavior in a controlled manner. Hence, this is **interdisciplinary**. Control system engineers analyze, design, and optimize complex systems which consist of highly integrated **coordination** of mechanical, electrical, chemical, **pneumatic**, electronic or pneumatic elements. Thus control engineering deals with diverse range of dynamic systems which include human and technological interfacing.

Control System

Control system engineering focuses on analysis and design of systems to improve the speed of response, **accuracy** and stability of system. The two methods of control system include classical methods and modern methods. The mathematical model of system is set up as first step followed by analysis, designing and testing. Necessary conditions for the stability are checked and finally optimization follows.

In classical method, mathematical modeling is usually done in time domain, frequency domain or complex s domain. Step response of a system is mathematically modeled in time domain differential analysis to find its settling time, % overshoot etc. Laplace transforms are most commonly used in frequency domain to find the open loop gain, phase margin, band width etc of system. Concept of transfer function, sampling of data, poles and zeros, system delays all comes under the classical control engineering stream.

Modern control engineering deals with Multiple Input Multiple Output (MIMO) systems, State space approach, Eigen values and **vectors** etc. Instead of transforming complex ordinary differential vectors, modern approach converts higher order equations to first order differential equations and solved by vector method.

Automatic control systems are most commonly used as it does not involve manual control. The controlled **variable** is measured and compared with a **specified** value to obtain the desired result. As a result of automated systems for control purposes, the cost of energy or power as well as the cost of process will be reduced increasing its quality and productivity.

Historical Review of Control Engineering

The application of Automatic control system is believed to be in use even from the ancient civilizations. Several types of water clock were designed and **implemented** to measure the time accurately from the third century BC, by Greeks and Arabs. But the first automatic system is considered as the Watts Fly ball Governor in 1788, which started the industrial revolution. The mathematical modeling of Governor is analyzed by Maxwell in 1868. In 19th century, Leonhard Euler, Pierre Simon Laplace and Joseph Fourier developed different methods for mathematical modeling. The second system is considered as Al Butz's Damper Flapper - thermostat in 1885. He started the company now named as Honeywell.

The beginning of 20th century is known as the golden age of control engineering. During this time classical control methods were developed at the Bell Laboratory by Hendrik Wade Bode and Harry Nyquist. Automatic controllers for steering ships were developed by Minorsky, Russian American Mathematician. He also introduced the concept of Integral and Derivative Control in 1920s. Meanwhile the concept of stability was put forward by Nyquist and followed by Evans. The transforms were applied in control system by Oliver Heaviside. Modern Control Methods were developed after 1950s by Rudolf Kalman, to overcome the limitation of classical Methods. PLC's were introduced in 1975.

Types of Control Engineering

Control engineering has its own categorization depending on the different methodologies used, which are as follows.

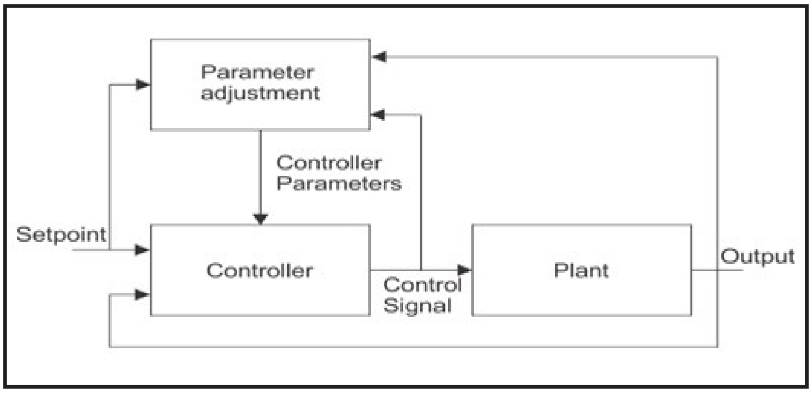
Classical Control Engineering : The systems are usually represented by using ordinary **differential equations**. In classical control engineering, these equations are transformed and analyzed in transformed domain. Laplace transform, Fourier transform and z transform are examples. This method is commonly used in Single Input Single Output systems.

Modern Control Engineering : In modern control engineering higher order differential equations are converted to first order differential equations. These equations are solved very similar to vector method. By doing so, many **complications** dealt in solving higher order differential equations are solved. These are applied in Multiple Input Multiple Output systems where analysis in frequency domain is not possible. Nonlinearities with multiple variables are solved by modern methodology. State space vectors, Eigen values and Eigen Vectors longs to this category. State Variables describe the input, output and system variables.

Robust Control Engineering : In robust control methodology, the changes in performance of system with change in parameters are measured for optimization. This aids in widening the stability and performance, also in finding alternate solutions. Hence in robust control the environment, internal inaccuracies, noises and disturbances are considered to reduce the fault in system.

Optimal Control Engineering : In optimal control engineering, the problem is formulated as mathematical model of process, physical constraints and performance constraints, to minimize the cost function. Thus optimal control engineering is the most **feasible** solution for designing a system with minimum cost.

Adaptive Control Engineering : In adaptive control engineering, the controllers employed are adaptive controllers in which parameters are made adaptive by some mechanism. The block diagram given below shows an adaptive control system



In this kind of controllers an additional loop for parameter adjustment is present in addition to the normal feedback of process.

Nonlinear Control Engineering : Non linear control engineering focuses on the non linearity's which cannot be represented by using linear ordinary differential equations. This system will exhibit multiple isolated equilibrium points, limit cycles, bifurcations with finite escape time. The main limitation is that it requires laborious mathematical analysis. In this analysis the system is divided into linear part and non linear part.

Game Theory : In game theory, each system will have to reduce its cost function against the disturbances / noises. Hence it is a study of conflict and co operation. The disturbances will try to maximize the cost function. This theory is related to robust and optimal control engineering.

I. Answer the following questions based on reading passage 1

1. In which domain are Laplace transforms used?

2. Which period is known as the golden age of control engineering? Why?

3. Why is control system engineering called "interdisciplinary"?

4. How is cost function minimized in optimal control engineering?

II. Decide if the following statements about reading passage1 are true or false

1. Minorsky introduced the concept of Integral and Derivative Control.
2. The first automatic system was introduced by Maxwell in 1868.

3. To overcome the limitation of classical methods, Rudolf Kalman developed modern control methods.

4.Water clocks are regarded as the first example of automatic control system.

III. Fill in the blank with the proper word

implemented-feasible-vector-differential equations- coordination-accuracy-principles-pneumatic

1. Many of these mathematicians turned to other topics such as topology, ………………., and functions of a complex variable.

2. Due to high costs, the program was never fully ……………..

3. Any pressurized bottle used for ……………operation must be filled with compressed air, nitrogen, or CO2.

4. I'm reading a book about the ……..……..of physics.

5. The electric field is a ……….quantity (meaning it has both a magnitude and a direction).

6. The manager is in charge of project ………………..

7. The government is looking for a ……………… way to create new jobs.

8. We tested the calculator for its.....................

IV. Fill in the blanks with words from reading passage1

1. Unwanted part of a signal is referee to as: ....

2. An assertion that two expressions are equal, expressed by writing the two expressions separated by an equal sign; from which one is to determine a particular quantity: ....

3. The design and operation of a system or process to make it as good as

possible in some defined sense: …….......

4. The major technological, socioeconomic and cultural change in the late 18th and early 19th century resulting from the replacement of an economy based on manual labour to one dominated by industry and machine manufacture: ……….....

V. Fill in the blanks with the best derivation of the words given

Accurate

1. The machines were not yet …………. enough to give useful results.
2. The watches made in Switzerland are well known for their………….**.**
3. The machine doesn't work………….**.**

Design

1. Do you know how to …………… a machine?
2. How does a machine ……..………earn per year?
3. I'm reading a book about the basic procedures of motor…......…**.**

Specify

1. Information cannot be identified or measured unless a certain mechanism is ……………..
2. She has identified and performed a ……………. research method.
3. Censorship, or more ……………. the banning of books, is a threat to the freedom of speech.

Reading Passage 2

Rudolf Kalman was born in Budapest, Hungary on 19 May 1930. He immigrated to the United States and obtained a Bachelor's and Master's degree in Electrical Engineering from M.I.T. in 1953, and 1954 respectively. He left M.I.T. and continued his studies at Columbia University where he received his ScD. in 1957.

His early interest in control systems was evident by his research at M.I.T. and especially at Columbia. From 1957 to 1958 Kalman was employed as a staff engineer at the IBM Research Laboratory in Poughkeepsie, N. Y. During that period of time he made important contributions to the design of linear sampled-data control systems using quadratic performance criteria, as well as in the use of Lyapunov theory for the analysis and design of control systems. He foresaw at that time the importance of the digital computer for large-scale systems.

In 1958 Kalman joined the Research Institute for Advanced Study (RIAS) which was started by the late Solomon Lefschetz. He started as a research mathematician and was promoted later to Associate Director of Research. It was during that period of time (1958-1964) that he made some of his truly pioneering contributions to modern control theory. He was instrumental in introducing the work of Caratheodory in optimal control theory, and clarifying the interrelations between Pontryagin's maximum principle and the Hamilton-Jacobi-Bellman equation, as well as variational calculus in general. His research not only stressed mathematical generality, but in addition it was guided by the use of the digital computer as an integral part of the design process and of the control system implementations.

It was also during his stay at RIAS that Kalman developed what is perhaps his most well known contribution, the so-called «Kalman filter». He obtained results on the discrete-time (sampled data) version of this problem in late 1958, and early 1959.
The Kalman filter, and its later extensions to nonlinear problems, represents perhaps the most widely applied by-product of modern control theory. It has been used in space vehicle navigation and control (e.g. the Apollo vehicle), radar tracking algorithms for ABM applications, process control, and socioeconomic systems.

Answer the following questions based on reading passage 2

1. What is Kalman's contribution to control theory?

2.What is regarded as the most widely applied by-product of modern control theory?

3.Where did Kalman study and work?

UNIT ELEVEN

Vocabulary: pronunciation, definition and example

Adequate: /ˈædəkwət/ satisfactory or acceptable in quality or quantity
The infrastructure is not adequate to take the amount of traffic there is now.

Amplitude: /ˈæmpləˌtud/ the maximum extent of a vibration or oscillation, measured from the position of equilibrium
These waves have amplitudes equal to 20 mm.

Assumption: /əˈsʌmpʃn/ a thing that is accepted as true or as certain to happen, without proof
they made certain assumptions about the market.

Attenuate: /əˈtɛnyuˌeɪt/ reduce the amplitude of (a signal, electric current, or other oscillation)
The filter must severely attenuate frequencies above 10 Hz.

Bypass: /ˈbaɪpæs/avoid or circumvent (an obstacle or problem)
A manager might bypass formal channels of communication.

Compressor: /kəmˈprɛsər/ an electrical device which reduces the dynamic range of a sound signal
Every audio channel has a compressor or expander, followed by a noise gate.

Constrain: /kənˈstreɪn/ severely restrict the scope, extent, or activity of
Agricultural development is considerably constrained by climate.

Degradation: /ˌdɛgrəˈdeɪʃn/ the process in which the beauty or quality of something is destroyed or spoiled
We all want to see recycling and an end to environmental degradation.

Distortion: /dɪˈstɔrʃn/ change in the form of an electrical signal or sound wave during processing
Distortion of sound is related to the length of the sound.

Extract: /ˈɛkstrækt/ Obtain (something such as money or information) from someone unwilling to give it
Information extracted by torture tends to be false.

Modulation: /ˌmɑdʒəˈleɪʃn/ alteration of the amplitude or frequency of an electromagnetic wave or other oscillation in accordance with the variations of a second signal
Modulation of the ray amplitude will result in sound being heard.

Multiplex: /ˈmʌltɪˌplɛks/ involving simultaneous transmission of several messages along a single channel of communication
The mobile phone is equipped for at least two frequency bands and

includes an antenna coupled to a multiplex type filter.

Optimal: /ˈɑptəməl/ best or most favourable; optimum
Under optimal conditions, these plants grow quite tall.

Oscillation: /ˌɑsəˈleɪʃn/ regular variation in magnitude or position about a central point, especially of an electric current or voltage
The oscillation frequency f is measured in cycles per second, or Hertz.

Probe: /proʊb/ an unmanned exploratory spacecraft designed to transmit information about its environment
Nasa directs the unmanned space probe Galileo to plunge into the atmosphere of the planet Jupiter, destroying the craft after a 14-year space mission.

Quantization: /kwɒntʌɪˈzeɪʃ(ə)n/ in mathematics and digital signal processing, is the process of mapping a large set of input values to a smaller set
The quantization of energy refers to the absorption or emission of energy in discreet packets, or quanta.

Redundant: /rɪˈdʌndənt/ not or no longer needed or useful; superfluous
Get rid of any redundant or unwanted items.

Satellite: /ˈsæt̬lˌaɪt/ an artificial body placed in orbit round the earth or another planet in order to collect information or for communication
The report was sent via satellite.

Sine: /saɪn/the trigonometric function that is equal to the ratio of the side opposite a given angle (in a right-angled triangle) to the hypotenuse
A sine wave or sinusoid is a mathematical curve that describes a smooth repetitive oscillation.

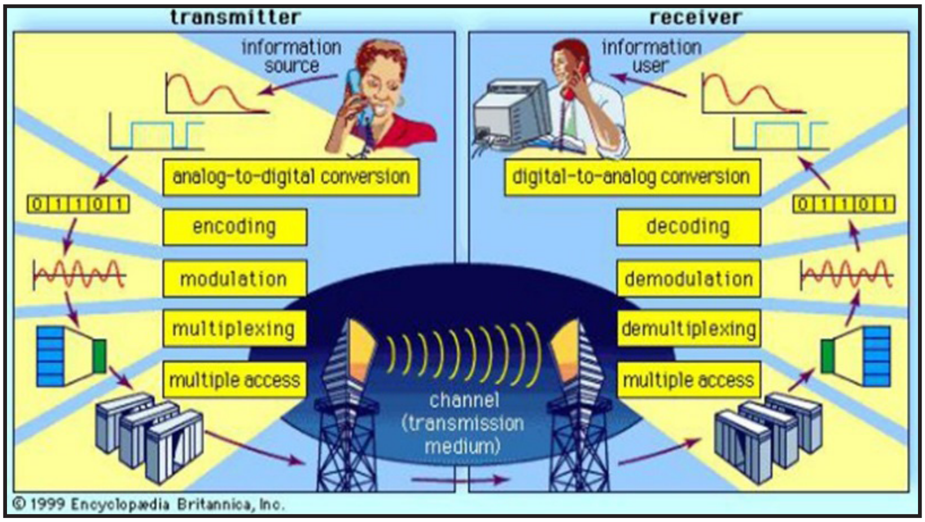
Take place: Occur
People laid flowers at the spot where the crash took place.

Volume: /ˈvɑlyəm/ an amount or quantity of something, especially when great
The volumes of data handled are vast.

Reading Passage 1

Telecommunication

Telecommunication is science and practice of transmitting information by electromagnetic means. Modern telecommunication centers on the problems involved in transmitting large **volumes** of information over long distances without damaging loss due to noise and interference. The basic components of a modern digital telecommunications system must be capable of transmitting voice, data, radio, and television signals. Digital transmission is employed in order to achieve high reliability and because the cost of digital switching systems is much lower than the cost of analog systems. In order to use digital transmission, however, the analog signals that make up most voice, radio, and television communication must be subjected to a process of analog-to-digital conversion. (In data transmission this step is **bypassed** because the signals are already in digital form; most television, radio, and voice communication, however, use the analog system and must be digitized.) In many cases, the digitized signal is passed through a source encoder, which employs a number of formulas to reduce **redundant** binary information. After source encoding, the digitized signal is processed in a channel encoder, which introduces redundant information that allows errors to be detected and corrected. The encoded signal is made suitable for transmission by **modulation** onto a carrier wave and may be made part of a larger signal in a process known as **multiplexing**. The multiplexed signal is then sent into a multiple-access transmission channel. After transmission, the above process is reversed at the receiving end, and the information is **extracted**.



Analog-to-digital Conversion

In transmission of speech, audio, or video information, the object is high fidelity—that is, the best possible reproduction of the original message without the **degradations** imposed by signal **distortion** and noise. The basis of relatively noise-free and distortion-free telecommunication is the binary signal. The simplest possible signal of any kind that can be employed to transmit messages, the binary signal consists of only two possible values. These values are represented by the binary digits, or bits, 1 and 0. Unless the noise and distortion picked up during transmission are great enough to change the binary signal from one value to another, the correct value can be determined by the receiver so that perfect reception can occur.

If the information to be transmitted is already in binary form (as in data communication), there is no need for the signal to be digitally encoded. But ordinary voice communications **taking place** by way of a telephone are not in binary form; neither is much of the information gathered for transmission from a space **probe**, nor are the television or radio signals gathered for transmission through a **satellite** link. Such signals, which continually vary among a range of values, are said to be analog, and in digital communications systems analog signals must be converted to digital form. The process of making this signal conversion is called analog-to-digital (A/D) conversion.

Sampling

Analog-to-digital conversion begins with sampling, or measuring the **amplitude** of the analog waveform at equally spaced discrete instants of time. The fact that samples of a continually varying wave may be used to represent that wave relies on the **assumption** that the wave is **constrained** in its rate of variation. Because a communications signal is actually a complex wave—essentially the sum of a number of component **sine** waves, all of which have their own precise amplitudes and phases—the rate of variation of the complex wave can be measured by the frequencies of **oscillation** of all its components. The difference between the maximum rate of oscillation (or highest frequency) and the minimum rate of oscillation (or lowest frequency) of the sine waves making up the signal is known as the bandwidth (B) of the signal. Bandwidth thus represents the maximum frequency range occupied by a signal. In the case of a voice signal having a minimum frequency of 300 hertz and a maximum frequency of 3,300 hertz, the bandwidth is 3,000 hertz, or 3 kilohertz. Audio signals generally occupy about 20 kilohertz of bandwidth, and standard video signals occupy approximately 6 million hertz, or 6 megahertz.

The concept of bandwidth is central to all telecommunication. In analog-to-digital conversion, there is a fundamental theorem that the analog signal may be uniquely represented by discrete samples spaced no more than one over twice the bandwidth (1/2B) apart. This theorem is commonly referred to as the sampling theorem, and the sampling interval (1/2B seconds) is referred to as the Nyquist interval (after the Swedish-born American electrical engineer Harry Nyquist). As an example of the Nyquist interval, in past telephone practice the bandwidth, commonly fixed at 3,000 hertz, was sampled at least every 1/6,000 second. In current practice 8,000 samples are taken per second, in order to increase the frequency range and the fidelity of the speech representation.

Quantization

In order for a sampled signal to be stored or transmitted in digital form, each sampled amplitude must be converted to one of a finite number of possible values, or levels. For ease in conversion to binary form, the number of levels is usually a power of 2—that is, 8, 16, 32, 64, 128, 256, and so on, depending on the degree of precision required. In digital transmission of voice, 256 levels are commonly used because tests have shown that this provides **adequate** fidelity for the average telephone listener.

The input to the quantizer is a sequence of sampled amplitudes for which there are an infinite number of possible values. The output of the quantizer, on the other hand, must be restricted to a finite number of levels. Assigning infinitely variable amplitudes to a limited number of levels inevitably introduces inaccuracy, and inaccuracy results in a corresponding amount of signal distortion. (For this reason **quantization** is often called a “lossy” system.) The degree of inaccuracy depends on the number of output levels used by the quantizer. More quantization levels increase the accuracy of the representation, but they also increase the storage capacity or transmission speed required. Better performance with the same number of output levels can be achieved by judicious placement of the output levels and the amplitude thresholds needed for assigning those levels. This placement in turn depends on the nature of the waveform that is being quantized. Generally, an **optimal** quantizer places more levels in amplitude ranges where the signal is more likely to occur and fewer levels where the signal is less likely. This technique is known as nonlinear quantization. Nonlinear quantization can also be accomplished by passing the signal through a **compressor** circuit, which amplifies the signal's weak components and **attenuates** its strong components. The compressed signal, now occupying a narrower dynamic range, can be quantized with a uniform, or linear, spacing of thresholds and output levels. In the case of the telephone signal, the compressed signal is uniformly quantized at 256 levels, each level being represented by a sequence of eight bits. At the receiving end, the reconstituted signal is expanded to its original range of amplitudes. This sequence of compression and expansion, known as companding, can yield an effective dynamic range equivalent to 13 bits.

Bit Mapping

In the next step in the digitization process, the output of the quantizer is mapped into a binary sequence. An encoding table that might be used to generate the binary sequence is shown below:

quantization level	binary code
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

It is apparent that 8 levels require three binary digits, or bits; 16 levels require four bits; and 256 levels require eight bits. In general 2^n levels require *n* bits.

In the case of 256-level voice quantization, where each level is represented by a sequence of 8 bits, the overall rate of transmission is 8,000 samples per second times 8 bits per sample, or 64,000 bits per second. All 8 bits must be transmitted before the next sample appears. In order to use more levels, more binary samples would have to be squeezed into the allotted time slot between successive signal samples. The circuitry would become more costly, and the bandwidth of the system would become correspondingly greater. Some transmission channels (telephone wires are one example) may not have the bandwidth capability required for the increased number of binary samples and would distort the digital signals. Thus, although the accuracy required determines the number of quantization levels used, the resultant binary sequence must still be transmitted within the bandwidth tolerance allowed.

Source Encoding

As is pointed out in analog-to-digital conversion, any available telecommunications medium has a limited capacity for data transmission. This capacity is commonly measured by the parameter called bandwidth. Since the bandwidth of a signal increases with the number of bits to be transmitted each second, an important function of a digital communications system is to represent the digitized signal by as few bits as possible—that is, to reduce redundancy.

I. Answer the following questions based on reading passage 1

1. Why are digital systems preferred over the analog ones?

2. What is the bandwidth of a signal?

3. How is the encoded signal made suitable for transmission?

4. Which step is bypassed in data transmission? Why?

II. Decide if the following statements about reading passage1 are true or false

1.The information received from voice communications should be digitally encoded.
2.Signal distortion occurs due to inaccuracy.
3.Digital systems are more economical than analog systems.
4.The degree of inaccuracy is determined by the number of output levels used by the quantizer.

III. Fill in the blank with the proper word

attenuated-extract-satellites-adequate-probe-amplitudes-optimal-assumption-

1.A frequency response of the transmission line is computed based on the measured ……….
2.We're working on the …………….. that the time of death was after midnight.
3.As a result of the high electrical conductivity of sea water, signals are ……….. rapidly as they propagate downward through it.
4.During criminal investigation police frequently resort to torture to ………. information from suspects.

5.Thanks to scientific ………… which monitor the sun, it is possible to know in advance when an aurora might occur.
6.He keeps his engine tuned for …………….. performance.
7.The tiny …………. is carrying six instruments to help it analyse the atmospheric make-up, take pictures and test surface samples.
8.The food was more than …………for the six of us.

IV. Fill in the blanks with words from the passage
1.The degree of exactness with which something is copied or reproduced: ……...
2.Individually separate and distinct: ………
3.A truth established by means of accepted truths: ……..
4.Ascertain the momentary value of (an analogue signal) many times a second so as to convert the signal to digital form: ……

V. Fill in the blanks with the best derivation of the words given
Compress
1.The… …………. of an already compressed voice signal degrades voice clarity.
2. The new video …………… technology will allow us to receive full-screen video over the Net.
Good ……………design includes a detector circuit that emulates the human ear by responding to average *signal* levels.

Oscillate
1.An ……………….voltage created an electric field across the gap to accelerate the particles each time around.
2.We used an electromechanical ……………. to apply a known vertical ………… to the rover antenna.

Quantize
1.Distortion is caused when very low-level audio signals are …………….
2.A good …………….. is one which represents the original signal with minimum loss or distortion.

3.Each region is encoded using a single selected …………… level, where quantizer values can differ between different regions.

Reading Passage 2

Harry Nyquist, (born Feb. 7, 1889, Nilsby, Sweden—died April 4, 1976, Harlingen, Texas, U.S.), American physicist and electrical and communications engineer, a prolific inventor who made fundamental theoretical and practical contributions to telecommunications.

Nyquist moved to the United States in 1907. He earned a B.S. (1914) and an M.S. (1915) in electrical engineering from the University of North Dakota. In 1917, after earning a Ph.D. in physics from Yale University, he joined the American Telephone and Telegraph Company (AT&T). There he remained until his retirement in 1954, working in the research department and then (from 1934) at Bell Laboratories. Nyquist continued to serve as a government consultant on military communications well after his retirement.

Some of Nyquist's best-known work was done in the 1920s and was inspired by telegraph communication problems of the time. Because of the elegance and generality of his writings, much of it continues to be cited and used. In 1924 he published "Certain Factors Affecting Telegraph Speed," an analysis of the relationship between the speed of a telegraph system and the number of signal values used by the system. His 1928 paper "Certain Topics in Telegraph Transmission Theory" refined his earlier results and established the principles of sampling continuous signals to convert them to digital signals. The Nyquist sampling theorem showed that the sampling rate must be at least twice the highest frequency present in the sample in order to reconstruct the original signal. In 1927 Nyquist provided a mathematical explanation of the unexpectedly strong thermal noise studied by J.B. Johnson. The understanding of noise is

of critical importance for communications systems. Thermal noise is sometimes called Johnson noise or Nyquist noise because of their pioneering work in this field.
In 1932 Nyquist discovered how to determine when negative feedback amplifiers are stable. His criterion, generally called the Nyquist stability theorem, is of great practical importance. In addition to Nyquist's theoretical work, he was a prolific inventor and is credited with 138 patents relating to telecommunications.

Answer the following questions based on reading passage 2

1.What does the Nyquist sampling theorem state?

2.When did Nyquist retire?

3.Which decade can be regarded as the most prolific in Nyquist's career?

UNIT TWELVE

Vocabulary: pronunciation, definition and example

Accelerate: /əkˈsɛləˌreɪt/ (especially of a vehicle) begin to move more quickly

The vehicle accelerates from 0 to 60 mph in roughly 16 seconds.

Debris: /dəˈbri/ scattered pieces of rubbish or remains

Flames shot out of the side of the building and debris rained down.

Deviate: /ˈdiviˌeɪt/ depart from an established course

You must not deviate from the agreed route.

Durable: /ˈdʊrəbl/ able to withstand wear, pressure, or damage; hard-wearing

The car is not made of stainless steel but instead it's made of some kind of durable alloy that can withstand bullets and rocket.

Geostationary: /ˌdʒioʊˈsteɪʃəˌnɛri/ (of an artificial satellite of the earth) moving in a circular geosynchronous orbit in the plane of the equator, so that it appears to be stationary in the sky above a fixed point on the

surface
Once in geostationary orbit above the equator this satellite will provide a wide range of high-speed telecommunications services for North America, South America, Europe, North Africa and the Middle East.

Hostile: /ˈhɑstaɪl/ showing or feeling opposition or dislike; unfriendly
People were hostile to his ideas.

Inhospitable: /ˌɪnhɑˈspɪt̬əbl/ (of an environment) harsh and difficult to live in
The country is basically uninhabitable and extremely inhospitable with the exception of the coastline.

Latency: /ˈleɪtnsi/ the delay before a transfer of data begins following an instruction for its transfer
Fast streaming technology reduces server latency.

Miniaturization: /ˌmɪniətʃərəˈzeɪʃn/ /ˌmɪniətʃərəˈzeɪʃn/ the process of making something very small using modern technology
The silicon chip is a classic example of the benefits of miniaturization.

Payload: / ˈpeɪloʊd/ the actual information or message in transmitted data, as opposed to automatically generated metadata
Each message contains a source, a destination, metadata, as well as the data payload itself.

Propel: /prəˈpɛl/ drive or push something forwards
The boat is propelled by using a very long paddle.

Propulsion: /prəˈpʌlʃn/ the action of driving or pushing forward
They dive and use their wings for propulsion under water.

Telemetry: /təˈlɛmətri/ the process of recording and transmitting the readings of an instrument
Measurements will be transferred by radio telemetry to the shore station.

Thruster: /ˈθrʌstər/a small rocket engine on a spacecraft, used to make alterations in its flight path or altitude
Using small thrusters, the spacecraft will rotate so that the solar panels are oriented perpendicular to the Sun.

Track: / træk/ follow the trail or movements of (someone or something), typically in order to find them or note their course
The aircraft was designed not to be tracked by radar.

Transponder: /trænˈspɑndər/ a device for receiving a radio signal and automatically transmitting a different signal
Most aircraft carry transponders, devices that relay a plane's identification, altitude and speed to ground controllers.

Velocity /vəˈlɑsət̬i/ the speed of something in a given direction
Roller coasters are also good demonstrators of speed, velocity, and acceleration.

Withstand: /wɪθˈstænd/remain undamaged or unaffected by; resist
The structure had been designed to withstand winds of more than 100 mph.

Reading Passage 1

How Satellites Work

A satellite is basically a self-contained communications system with the ability to receive signals from Earth and to retransmit those signals back with the use of a **transponder**—an integrated receiver and transmitter of radio signals. A satellite has to **withstand** the shock of being **accelerated** during launch up to the orbital **velocity** of 28,100 km (17,500 miles) an hour and a **hostile** space environment where it can be subject to radiation and extreme temperatures for its projected operational life, which can last up to 20 years. In addition, satellites have to be light, as the cost of launching a satellite is quite expensive and based on weight. To meet these challenges, satellites must be small and made of lightweight and **durable** materials. They must operate at a very high reliability of more than 99.9 percent in the vacuum of space with no prospect of maintenance or repair.

Intelsat VI, a communications satellite, after being repaired, 1992.

The main components of a satellite consist of the communications system, which includes the antennas and transponders that receive and retransmit signals, the power system, which includes the solar panels that provide power, and the **propulsion** system, which includes the rockets that **propel** the satellite. A satellite needs its own propulsion system to get itself to the right orbital location and to make occasional corrections to that position. A satellite in **geostationary** orbit can **deviate** up to a degree every year from north to south or east to west of its location because of the gravitational pull of the Moon and Sun. A satellite has **thrusters** that are fired occasionally to make adjustments in its position. The maintenance of a satellite's orbital position is called "station keeping," and the corrections made by using the satellite's thrusters are called "attitude control." A satellite's life span is determined by the amount of fuel it has to power these thrusters. Once the fuel runs out, the satellite eventually drifts into space and out of operation, becoming space **debris**.

A satellite in orbit has to operate continuously over its entire life span. It needs internal power to be able to operate its electronic systems and communications **payload**. The main source of power is sunlight, which is harnessed by the satellite's solar panels. A satellite also has batteries on board to provide power when the Sun is blocked by Earth. The batteries are recharged by the excess current generated by the solar panels when there is sunlight.

Satellites operate in extreme temperatures from −150 °C (−238 °F) to 150 °C (300 °F) and may be subject to radiation in space. Satellite components that can be exposed to radiation are shielded with aluminium and other radiation-resistant material. A satellite's thermal system protects its sensitive electronic and mechanical components and maintains it in its optimum functioning temperature to ensure its continuous operation. A satellite's thermal system also protects sensitive satellite components from the extreme changes in temperature by activation of cooling mechanisms when it gets too hot or heating systems when it gets too cold.

The **tracking telemetry** and control (TT&C) system of a satellite is a two-way communication link between the satellite and TT&C on the ground. This allows a ground station to track a satellite's position and control the satellite's propulsion, thermal, and other systems. It can also monitor the temperature, electrical voltages, and other important parameters of a satellite.

Communication satellites range from microsatellites weighing less than 1 kg (2.2 pounds) to large satellites weighing over 6,500 kg (14,000 pounds). Advances in **miniaturization** and digitalization have substantially increased the capacity of satellites over the years. Early Bird had just one transponder capable of sending just one TV channel. The Boeing 702 series of satellites, in contrast, can have more than 100 transponders, and with the use of digital compression technology each transponder can have up to 16 channels, providing more than 1,600 TV channels through one satellite.

Satellites operate in three different orbits: low Earth orbit (LEO), medium Earth orbit (MEO), and geostationary or geosynchronous orbit (GEO). LEO satellites are positioned at an altitude between 160 km and 1,600 km (100 and 1,000 miles) above Earth. MEO satellites operate from 10,000 to 20,000 km (6,300 to 12,500 miles) from Earth. (Satellites do not operate between LEO and MEO because of the **inhospitable** environment for electronic components in that area, which is caused by the Van Allen radiation belt.) GEO satellites are positioned 35,786 km (22,236 miles) above Earth, where they complete one orbit in 24 hours and thus remain fixed over one spot. As mentioned above, it only takes three GEO satellites to provide global coverage, while it takes 20 or more satellites to cover the entire Earth from LEO and 10 or more in MEO. In addition, communicating with satellites in LEO and MEO requires tracking antennas on the ground to ensure seamless connection between satellites.

A signal that is bounced off a GEO satellite takes approximately 0.22 second to travel at the speed of light from Earth to the satellite and back. This delay poses some problems for applications such as voice services and mobile telephony. Therefore, most mobile and voice services usually use LEO or MEO satellites to avoid the signal delays resulting from the inherent **latency** in GEO satellites. GEO satellites are usually used for broadcasting and data applications because of the larger area on the ground that they can cover.

Launching a satellite into space requires a very powerful multistage rocket to propel it into the right orbit. Satellite launch providers use proprietary rockets to launch satellites from sites such as the Kennedy Space Center at Cape Canaveral, Florida, the Baikonur Cosmodrome in Kazakhstan, Kourou in French Guiana, Vandenberg Air Force Base in California, Xichang in China, and Tanegashima Island in Japan. The U.S. space shuttle also has the ability to launch satellites.

Satellite communications use the very high-frequency range of 1–50 gigahertz (GHz; 1 gigahertz = 1,000,000,000 hertz) to transmit and receive signals. The frequency ranges or bands are identified by letters: (in order from low to high frequency) L-, S-, C-, X-, Ku-, Ka-, and V-bands. Signals in the lower range (L-, S-, and C-bands) of the satellite frequency spectrum are transmitted with low power, and thus larger antennas are needed to receive these signals. Signals in the higher end (X-, Ku-, Ka-, and V-bands) of this spectrum have more power; therefore, dishes as small as 45 cm (18 inches) in diameter can receive them. This makes the Ku-band and Ka-band spectrum ideal for direct-to-home (DTH) broadcasting, broadband data communications, and mobile telephony and data applications.

I. Answer the following questions based on reading passage 1

1. What is a satellite mainly made up of?

2. Why is the TT&C system of a satellite a two-way communication?

3. What does a propulsion system do in a satellite?

4. What's the significance of the weight of a satellite?

II. Decide if the following statements about reading passage1 are true or false

1.The heavier satellites are more beneficial.

2.Satellites can't operate in temperatures above 300 °F.

3.Compared to LEO and MEO, GEO satellites cover larger area on the ground.

4.Communication satellites vary in size.

III. Fill in the blank with the proper word

latency-velocity-withstands-durable-transponder-propelled-tracked-inhospitable

1.Tibetans still form a majority of people living in the …………….. countryside.

2. The material ………….. rain and wind without rotting.

3. If the network is busy, then voice calls can suffer from ……….. and the quality of the service becomes unacceptably low.

4. John usually wears …………… yet comfortable black nylon pants and thick sneakers.

5. If an object is moving in one direction without a force acting on it, then it continues to move in that direction with a constant …………….

6. An intricate system of magnetic fields ……………….the craft along and away from Earth.

7. The ………………transmits this coded signal using the tuned circuit.

8. The radars picked up and ……………. the pieces of the shuttle as they fell to Earth.

IV. Fill in the blanks with words from reading passage1

1.Send (a missile, satellite, or spacecraft) on its course: ………..

2.The length of time for which a person or animal lives or a thing functions: ....

3.A high-capacity transmission technique using a wide range of frequencies, which enables a large number of messages to be communicated simultaneously: ……...

4.A piece of radio or television apparatus that detects broadcast signals and converts them into visible or audible form: …...……

V. Fill in the blanks with the best derivation of the words given

Operate

1.To make sure your system ………………….. efficiently, examine it frequently.

2.The Program was announced on 13 December 2001 and became ……………on 28 January this year.

3.The provincial power shortage will be eased when the new nuclear power plant is put into …………….

Miniaturize

1.The devices seem to perform better the more they are …………..

2.Recent designs have ……………... electrical motors.

3……………. roses have little or no fragrance.

Orbit

1.This nearly polar ……………. is designed such that the spacecraft's ……………path moves at the same apparent rate as the sun.

2.Like planets, comets …………. the sun, but their path is usually long and narrow.

Reading Passage 2

Sergey Pavlovich Korolyov, (born Jan. 12, 1907 [Dec. 30, 1906, Old Style], Zhitomir, Russia—died Jan. 14, 1966, Moscow, Russia, U.S.S.R.),worked as the lead Soviet rocket engineer and spacecraft designer during the Space Race between the United States and the Soviet Union in the 1950s and 1960s. He is considered by many as the father of practical astronautics.

Although Korolyov trained as an aircraft designer, his greatest strengths proved to be in design integration, organization and strategic planning. Arrested for alleged mismanagement of funds (he spent the money on unsuccessful experiments with rocket devices), he was imprisoned in 1938 for almost six years, including some months in a Kolyma labour camp. Following his release he became a recognized rocket designer and a key figure in the development of the Soviet Intercontinental ballistic missile program. He was then appointed to lead the Soviet space program and made a Member of Soviet Academy of Sciences, overseeing the early successes of the Sputnik and Vostok projects including the first human Earth orbit mission by Yuri Alexeevich Gagarin on 12 April 1961. Korolyov's unexpected death in 1966 interrupted implementation of his plans for a Soviet manned Moon landing before the United States 1969 mission.

Before his death he was officially identified only as *Chief Designer*, to protect him from possible cold war assassination attempts by the United States.Only following his death in 1966 has he received appropriate public recognition as the driving force behind Soviet accomplishments in space exploration during and following the International Geophysical Year.

Answer the following questions based on reading passage 2

1. Why was Korolyov arrested?

2. What was the title given to Korolyov during his lifetime?

3. Why did Korolyov receive public attention only after his death?

Bibliography

Alessandro Volta. Retrieved August 14, 2016 from https://www.britannica.com/biography/Alessandro-Volta.

All about Circuits. Retrieved December,24,2016 from http://www.allaboutcircuits.com/textbook/alternating-current/chpt-1/what-is-alternating-current-ac/

Anderson, L. (1992). *Nikola Tesla on His Work with Alternating Currents ands Their Application to Wireless Telegraphy, Telephony, and Transmission of Power*. Colorado: Twenty First Century Books.

Azar, B. & Stacy A. H. (2009). *Understanding and Using English Grammar.* NY: Pearson Education.

Baker,A. C. (1991). *Tidal Power*.UK: Peter Peregrinus.

Bakshi, V. U. (2009). *Control Systems*. India: Technical Publications.

Barnett, D.& Bjornsgaard, K.(2000). *Electrical Power Generation*. Oklahoma: PennWell.

Bodansky, D. (1996). *Nuclear Energy*. USA: Springer

Breeze, P. (2005). *Power Generation Technologies*. Oxford: Newnes.

Caverly, D. P. (1952). *Premier of Electronics and Radiant Energy*.USA: MacGraw-Hill

Charlier, R. H & Finkl, C. W. (2009). *Ocean Energy*. Heidelberg: Springer.

Christianson, D. & et.al. (2005). *Standard Handbook of Electrical Engineering*.US: McGraw-hill.

Christison, M. A.& et.al. (2015). *Teaching and Learning English Grammar*. New York: Routledge.

Dalgleish,D.I. (1989). *An Introduction to Satellite Communications*.UK: Peter Peregrinus Ltd.

Datta, S. (2005). *Quantum Transport: Atom to Transistor*. UK: Cambridge University Press.

Dipippo, R. (2012).*Geothermal Power Plants*.USA: Elsevier.

Dokić, B. L. & Blanuša, B. (2015). *Power Electronics*.US: Springer Publishing.

Energy Story. Retrieved July 2,2016, from http://www.energyquest.ca.gov/story/chapter02.html

Electrical4u. Retrieved August,5,2016, from http://www.electrical4u.com/what-is-capacitor-and-what-is-dielectric/

Erickson, R. W., Maksimovic, D. (2001). *Fundamentals of Power Electronics*.US: Springer Publishing.

ExplainthatStuff. Retrieved May,7,2016, from
http ://www.explainthatstuff.com/transformers.html

Freeman, R. L. (2005). *Telecommunication Systems*.US: Wiley.

Forrest, M. (2003).*Getting Started in Electronics*. Lincolnwood: Master Publishing Inc.

Glendinning, H.E., & Glendinning,N. (1995). *Oxford English for Electrical and Mechanical Engineering*. UK: Oxford University Press.

Greenbaum, S. (1996). *Oxford English Grammar*.UK: Oxford University Press.

Greenbaum,S. (2000). *Oxford Reference Grammar*. UK: Oxford University Press.

Grigsby, L. L. (2012). *Electric Power Generation, Transmission, and Distribution*.USA: CRC Press.

Georg Ohm. Retrieved December 20,2016 from https://www.britannica.com/biography/Georg-Ohm**.**

Harry Nyquist. Retrieved August 5,2016 from https://www.britannica.com/biography/Harry-Nyquist.

Hofmann, J.R. (1995). *Andre-Marie Ampere*.UK: Cambridge University press.

How Stuff Works. Retrieved December,26,2016, from http://electronics.howstuffworks.com/transistor1.htm

Joseph Henry. Retrieved October 5, 2016 from: https://www.britannica.com/biography/Joseph-Henry

Kiessling, F. & et. al. (2003). *Overhead Power Lines*. US: Springer Publishing.

Lewis. T. (2014). *What is an MRI*. Retrieved from http://www.livescience.com/39074-what-is-an-mri.html

LISTVERSE. Retrieved October,24,2016, from http://listverse.com/2009/05/01/top-10-renewable-energy-sources/

Longman Dictionary of Contemporary English (6th edition.). (2016). USA: Pearson Education ESL.

Lowe, D. (2012). *Electronics for Dummie*. New Jersey: Wiley.

Mahon, B. (2003).*The Man Who Changed Everything: the Life of James Clerk Maxwell.* UK:Wiley.

Maral, G. & Bousquet, M. (2009). *Satellite Communications Systems*.UK: Wiley.

Merriam-Webster's Dictionary &Thesaurus. (2014). Springfield, MA: Merriam-
Webster Inc.

Michael Faraday. Retrieved September 12, 2016 from: https://www.britannica.com/biography/Michael-Faraday.

Ogata, K. (2010). *Modern Control Engineering*.US: Prentice Hall.

Olien, B. (2003). *Electricity*. Minnesota: Capstone Press.

Oxford Advanced Learner's Dictionary of Current English. (2015). Oxford: Oxford University Press.

Pansini,A.J. (2005).*Power Transmission and Distribution*. USA: The Fairmont Press INC.

Paraskevopoulos. P.N. (2002). *Modern Control Engineering*. NY: Marcel Dekker Inc.

Patil,M. & Rodey, P.(2015). *Control Systems for power Electronics*.US: Springer Publishing

Popovich,M. & et. al. (2007). *Power Distribution Networks with On-Chip Decoupling Capacitors*.USA: Springer.

Reddy,P. J. (2012). *Solar Power Generation.* The Netherlands: CRC Press.

Rudolf E. Kalman. Retrieved September 2, 2016 from: https:www.britannica.com/contributor/Rudolf-E-Kalman/1515

Seifer,M.J.(1996). *The Life and Times of Nikola Tesla.* NY: Citadel Press.

Sergey Pavlovich Korolyov. Retrieved September 6, 2016 from https:www.britannica.com/biography/Sergey-Pavlovich-Korolyov.

Shurkin, J.N. (2006). *The Rise and Fall of William Shockley; Creator of the Electronic Age.* London: Macmillan.

Sinha, N.K. (2008) *Control Systems*. Delhi: New Age International.

Sørensen, B. (2004). *Renewable Energy*. Denmark: *Elsevier Academic Press.*

Stone, G.C. & et. al. (2004). *Electrical Insulation for Rotating Machines: Design ,Evaluation, Aging, Testingand Repair*.USA:Wiley.

Thomas, Isabel. (2007). *The Pros and Cons of Biomass Power*. Canada: The Rosen Publishing Group.

Tong, W. (2010). *Wind Power Generation and Wind Turbine Design*. Boston: WIT Press.

Union of Concerned Scientists. Retrieved May,16,2016, from http://www.ucsusa.org/clean-energy/how-electricity-grid-works#.WIyHa1zl_WQ

Viswanathan,T. (2015). *Switching Systems and Networks*. Delhi: PHI Learning Private Limited.

Wadhwa, C.L. (1993). *Generation , Distribution and Utilization of Electrical Energy.* Delhi: New Age International Ltd.

Walker,J., Halliday,D., &Resnick, R. (2011). *Fundamentals of Physics* .Hoboken, NJ:Wiley.

Walker., S.M.(2012). *Investigating Electricity*.USA: Lerner Publication Company.

Willis,L.H. & Walter, G.S. (2000). *Distributed Power Generation*. NY: Marcel Dekker, Inc.