Glossary

Note: Many terms in this glossary may have other meanings. They are described here in the context of this course.

absolute magnitude	the brightness of a star on the magnitude scale from a distance of 10 parsecs
absorption spectra	the characteristic dark lines at particular frequencies/wavelengths against a continuous background spectrum produced by light passing through gaseous elements or molecules
active optics	the manipulation of a telescope's mirror to adjust its shape to minimise distortion caused by the mirror
adaptive optics	the continuous adjustment of a received wavefront in a telescope to compensate for the effects of atmospheric blurring
aether wind	according to the aether theory, Earth's motion through the aether as it revolves around the Sun would cause a flow of aether through the Earth
alternating current	electric current produced by electrons oscillating back and forth within a conductor
amplifier	a device that makes an electrical signal larger than the original
analogue/analog	electrical signals having a continuously varying voltage
angular separation	the angle formed at an observer by the position of two objects drawn to the observer
angular speed	the angle being swept out per second from a central point, usually during circular motion
anode	the positive electrode in a galvanic cell or in a gas discharge or cathode ray tube
anti-nodes	points on a standing wave having maximum displacement
anti-parallel alignment	the direction of the magnetic spin axis of rotating nuclei is opposite to an applied magnetic field direction
apparent magnitude	the brightness a star appears to be from an observer on Earth
artificial transmutation	the changing of an atom's nucleus from one element to another by artificial methods
β^- decay	the emission of an electron from the nucleus causing a transmutation of that nucleus
β^+ decay	the emission of a positron from the nucleus causing a transmutation of that nucleus
back EMF	the production in the coils of a spinning electric motor of an EMF that opposes the supplied voltage
Balmer series	a series of hydrogen emission (or absorption) lines caused by electrons falling back (jumping from) energy level n = 2
baryons	a family of subatomic particles composed of three quarks of which neutrons and protons are examples
BCS theory	the theory that explains the behaviour of electric current through superconductors by the formation of Cooper pairs of electrons
binding energy	the energy that holds all the particles of matter together in the nucleus of an atom (see mass deficit)
binding energy per nucleon	the energy holding each particle (nucleon) within a nucleus (i.e. binding energy/number of nucleons in the nucleus)
bipolar transistor	a device that consists of a pair of PN junctions sharing a common region of semiconductor
black body radiation	the characteristic radiation emitted from a perfect emitter (one that emits at all wavelengths) at a given temperature
bremsstrahlung (braking) radiation	electromagnetic radiation (EMR) emitted from electrons as X-rays when they are being decelerated rapidly
cathode	the negative electrode in a galvanic cell or in a gas discharge or cathode ray tube
cathode ray	a stream of electrons within a cathode ray (vacuum) tube emanating from the cathode and moving towards the anode
centripetal acceleration (a_c)	acceleration of an object when it is undergoing uniform circular motion, directed towards the centre of the circle
centripetal force (F_c)	the force keeping an object in uniform circular motion directed towards the centre of the circle
charge to mass ratio	a particle's charge divided by its mass—an electron has a very large charge to mass ratio
compressions	the bunching up or coming together of the particles in a medium when a longitudinal wave passes
computed axial tomography (CT)	the way in which an image of an organ is generated by taking X-rays or imaging by other methods in slices

conduction band	the range of energy levels required by electrons in a substance to be able to move or migrate through the substance and conduct electricity
conductivity	the ease with which a material allows a flow of electric current through it
constant linear orbital speed	the constant speed with which an object undergoing uniform circular motion moves around its circular path
constructive interference	when two or more waves coincide and produce a resultant wave with a larger amplitude
continuous Doppler mode	a type of ultrasound application able to measure the speed of blood flowing through the heart or vessels
continuous spectra	unbroken emission spectra produced by hot (incandescent) objects with a continuous range of wavelengths
controls	the subject of an experiment that does not have any variables altered
Cooper pair	two electrons moving through a superconducting material that interact with each other and the lattice so that they experience no resistance
critical angle	the angle of incidence that gives an angle of refraction of 90° to the normal
critical mass	the minimum mass of fissionable matter required for an uncontrolled nuclear chain reaction to occur
critical temperature (T_c)	the temperature at which a certain substance becomes a superconductor
current balance	laboratory apparatus designed to measure the force on a current-carrying conductor placed in a magnetic field
curved array/sector scan	an ultrasound scan that spreads out at an angle to form an image in the shape of a sector
delocalised valence electrons	electrons in a conducting material, usually a metal, that are no longer associated with a particular nucleus and are free to migrate through the lattice
dependent variable	In an investigation, the variable being measured that is subject to change by deliberately changing another factor
depletion zone	the region around the junction of n and p type semiconductors where electrons have migrated across from the n into the p type so that there is a region where few or no charge carriers (electrons or holes) still exist
destructive interference	when two or more waves coincide out of phase and the resultant wave has a smaller amplitude than the component waves
digital circuit	an electronic circuit designed for the manipulation of digital (binary) information
diode	an electronic device made from a single p-n junction that allows current to flow in one direction only
diode valve	a thermionic device allowing current flow in one direction only
Doppler effect	the shortening or lengthening of the wavelength of waves when the observer's relative motion is towards or away from (respectively) the source of the waves
drift velocity	the net velocity of electrons moving through a conductor
duplex scan	an ultrasound method used to image the flow of blood through veins and arteries
echo delay time (TE)	the time delay for an MRI signal to be returned from the target after the RF pulse
eddy current	the circular flow of current in a conducting sheet that give rise to a magnetic field
electric field	the region around an electric charge or charged surface in which another electric charge will experience a force
electric motor	a mechanical device that transforms electrical energy into torque in order to do work
electromagnetic force	the force associated with moving charges within magnetic fields; one of the four fundamental forces in nature
electromagnetic induction	the production of an electric current in a conductor subjected to a changing magnetic flux
electromagnetic radiation (EMR)	oscillating electric and magnetic fields which self-propagate, can travel through a vacuum and do so at 3.0×10^8 m s^{-1}
electromotive force (EMF)	the energy in joules given to each coulomb of electrons passing through a source of electrical energy (galvanic cell or generator); the voltage of a power source
electron density	the number of (conducting) electrons per unit volume within a conductor
electron-hole pair conduction	the method by which electric current flows through doped semiconductor material

emission spectra	light emitted at only specific wavelengths from an energised source by electrons falling to lower energy levels
emitter	one of the three connections made to a transistor
EMR spectrum	electromagnetic radiation spectrum: the full range of wavelengths of electromagnetic radiation
endoscopy	a medical procedure whereby an endoscope comprised of optical fibres for lighting and viewing the subject by the doctor is inserted into the body
energy band	a range of energies for electrons usually in reference to valence and conduction bands
energy shells/principle energy shells	the first of the energy levels assigned to electrons in quantum mechanics
escape velocity	the minimum speed required by an object so that it will completely escape a planet's (or other body's) gravitational field
exclusion principle	no two electrons can share the same quantum numbers in the same atom
external circuit	a pathway external to the source for electric current to flow around from one electrode to the other
fictitious force	an "inertial force" that must be used to explain the observed motion of objects within a non-inertial (accelerating) frame of reference
forbidden energy gap	the difference between the valence energy band and the conduction band in insulators
forward biased	the application of a voltage to a diode in the direction of allowed current flow
fuel rods	rods containing the nuclear fuel (usually enriched uranium) in a nuclear reactor
gadolinium	the element with number 64, a rare earth metal used as a contrast agent in MRI procedures
gamma camera	a specialised camera used to detect gamma radiation
general relativity	the relativity referred to in Einstein's general Theory of Relativity which describes gravity as an effect of the warping of space-time
generator	a mechanical device similar in construction to a motor which is made to rotate by an applied mechanical force and produces electrical energy
geostationary	a term applied to the orbit of geostationary satellites having a period equal to the rotational period of Earth and being placed above the equator so that they stay above the same point on the Earth's surface
germanium	the element with atomic number 32, a semi-metal which was used as an early semiconductor
gradient coils	used in MRI machines to produce a varying magnetic field strength
gradient magnetic field	a magnetic field which changes in strength/intensity through one axis in MRI scanning techniques to enable three dimensional imaging
gravitational force	the force experience by a mass within a gravitational field caused by that field; one of the four fundamental forces of nature
grey scale	a scale of white-black intensity used in black and white images for contrast
hadrons	particles comprised of bound quarks held together by the strong nuclear force which include baryons and mesons
hard X-rays	X-rays being in the high frequency/short wavelength range for X-rays which therefore have greater penetrating power
heat exchanger	an arrangement in which heat is transferred from one substance to another without the substances themselves making physical contact
hydrogen emission spectrum	the characteristic wavelengths of radiation emitted by excited hydrogen atoms
hyperfine spectral lines	the very fine splitting of emission lines into several fainter lines when the source is subjected to a magnetic field
illuminating optical fibre bundles	a non-coherent bundle (group) of optical fibres used in endoscopes for the purpose of shining light onto the subject
independent variable	the variable being changed in an investigation in order to measure its effect
induction motor	an electric motor having no electrical connection to the rotor as it generates torque due to induced current within the rotor
inertial frame of reference	a non-accelerating frame of coordinates against which measurements are made in which the motion of objects can be explained using existing laws of physics
integrated circuit	a miniaturised electronic circuit usually etched onto one silicon chip, also known as microchips
intensity	power per unit area (as applied to wave energy) measured in W m^{-2}

interferometry the technique of combining the received signals from more than one source with the purpose of increasing the resolution (as in radio astronomy)

inverse square law expressed as $I \propto \frac{1}{d^2}$ as the intensity (I) of a wave or radiation is inversely proportional to the square of the distance (d) from the source

isotopes atoms/nuclei with the same atomic number but different atomic mass due to differences in the number of neutrons

Kepler's third law the law of periods found by Kepler empirically as applied to the motion of the planets around the Sun

key-hole surgery surgery performed using a type of endoscope to reduce the size of the incision (cut) required

kinetic energy energy possessed by a body due to its motion given by $E_K = 1/2mv^2$

lamination having a layered structure—layers of insulation between sheets of soft iron make the laminated core of a transformer

Larmor frequency the precession frequency of spinning protons when subjected to a magnetic field

launching window the time period during which a satellite or space probe is best launched to achieve its desired orbit or trajectory

law of conservation of energy the law of physics that states that energy cannot be created nor destroyed but only transformed into other forms

law of universal gravitation or Newton's law of universal gravitation where $F = G\frac{m_1 m_2}{d^2}$, i.e. there exists a force of gravity F between any two objects with masses m_1 and m_2 separated by a distance d

laws of motion see Newton's laws of motion

light year the distance light travelling at 3.0×10^8 m s^{-1} will travel in one Earth year

line of best fit a line drawn on a graph which passes as close to the plotted points as possible

linear array/linear scan an ultrasound technique used to focus the ultrasound waves to improve image quality

linear orbital speed the instantaneous speed of an object in orbit

linear orbital velocity the instantaneous velocity of an object in orbit

longitudinal waves wave motion where the motion of the medium is in the same direction and back and forth (i.e. longitudinal) to the direction of propagation of the wave

low Earth orbit (LEO) an orbit with an altitude between 200 and 1000 km

Lyman series a series of Hydrogen emission lines in the ultraviolet region originating from electrons falling to energy level n = 1

magnetic field lines lines representing the magnetic force field around a source of magnetism

magnetic field a region around a source of magnetism within which a magnet will experience a force

magnitude a brightness scale used by astronomers with the brighter objects having a lower magnitude; a magnitude difference of 5 is a brightness ratio of 100

mass the amount of matter; either gravitational or inertial

mass defect the difference between the masses of individual particles in a nucleus and the mass of the whole nucleus; see 'binding energy'

matter anti-matter pairs a particle of matter and its anti-matter equivalent—when the pair coincide they are annihilated and their mass is converted to energy

matter wave all matter has a wave-like nature with wavelength given by de Broglie's relationship: $\lambda = \frac{h}{p}$

mechanical wave a wave requiring a medium and causing the disturbance of a physical medium for propagation to occur

Meissner effect the exclusion of a magnetic field from a superconductor (giving rise to the levitation of a magnet placed above a superconductor)

meson a particle in the family of bosons and group of hadrons with a short half-life; formed in the upper atmosphere through the interaction of cosmic rays

Metal Oxide Semiconductor Field Effect Transistor (MOSFET) a common transistor found in digital and analogue circuits used to amplify or switch electronic signals

microchip see 'integrated circuit'

moderator used to slow neutrons down to thermal speeds (which can then cause fission) in a nuclear reactor core

motor effect the force on a current-carrying conductor within a magnetic field

moving length the measured length of an object moving at a relativistic speed

moving time the time observed to pass on an object moving at a relativistic speed

multistage rocket a launch vehicle designed with two or more separate sets of rocket motors that can be jettisoned once the fuel is consumed

nebula a body of interstellar gas and/or dust reflecting light from nearby stars or emitting light

negative *g* force the sensation of being pulled upwards due to the downwards acceleration of the occupant's vehicle/craft

net magnetisation (M) in MRI, the overall magnetisation of the proton spin magnetic moment after being subjected to an external magnetic field

neutrino elementary particles that travel at almost the speed of light, have negligible mass and rarely interact with matter

newton (N) the unit of force; one newton of force is required to give a mass of one kilogram an acceleration of one metre per second squared

nodes points on standing waves having zero amplitude

non-inertial frame of reference a reference frame against which measurements are made which has non-zero acceleration so that inertial (fictitious) forces must be used to explain the motion of objects within

nuclear medicine medical procedures or treatments which use, either directly or indirectly, nuclear radiation

nucleus the central part of an atom containing all the positive charge and most of the mass as protons and neutrons

objective optical fibre bundle the bundle of optical fibre used in an endoscope that performs the function of an objective lens

Ohm's law the current through a resistance is proportional to the potential difference across the resistance, i.e. $R = \frac{V}{I}$

orbital decay the loss of altitude of a satellite or spacecraft caused by friction with Earth's upper atmosphere

parallax the method of calculating the distance to a nearby star by measuring the angle formed by the star's shift in position in the sky relative to the background of distant stars

parallel alignment the alignment of the net magnetic field from the spin of protons with the applied external magnetic field

parsec the distance to a star having a parallax angle of one arcsecond being approximately 3.26 light years

particle accelerator a machine that is designed to accelerate charged particles to relativistic speeds

Paschen series a series of Hydrogen emission lines in the infrared region originating from electrons falling to energy level n = 3

period (T) the time taken for one revolution/rotation/oscillation

phase encoding used in MRI for spatial localisation enabling precise imaging in three dimensions

phosphors material on television screens that phosphoresce, giving off light with a certain colour, when struck by electrons

photocurrent an electric current produced by electrons emitted from the surface of a cathode due to the photoelectric effect

photoelectric effect the emission of electrons from the surface of a metal when illuminated by light with a frequency greater than the metal's threshold frequency

photoelectrons electrons emitted due to the photoelectric effect

photon an elementary particle, the basic unit of light having energy proportional to its frequency $E = hf$

piezoelectric materials substances which change dimensions when an electric field is applied or which produce an electric field when subjected to mechanical force

polarity the orientation of an electric or magnetic dipole, e.g. positive/negative or north/south

positive *g* force the sensation of feeling heavier than normal due to the upwards acceleration of the occupant's vehicle/craft

positive hole	the lack of an electron in the lattice bonding which can migrate through the material acting as a positive charge carrier
positron	the anti-matter pair of an electron: a positive electron
precession	the revolving of the spin axis of a rotating body about a centrally-oriented axis
primary coil	the coil connected to the power supply in a transformer
primary coolant	the substance used to transfer heat away from the core of a nuclear reactor
pulse Doppler mode	a technique used in ultrasound imaging to provide information about the flow of blood through arteries or the heart
quantum mechanics	a set of principles that describes the physics of very small units such as energy which exists as discrete quantities rather than as a continuum
quantum physics	the study of the smallest units of the physical world in which quantities exist as discrete amounts
quantum theory	the theory underlying quantum mechanics
quark	a type of subatomic particle that are found in hadrons such as protons and neutrons
radial magnetic field	a magnetic field shaped so that it is constant or nearly constant over arrange of angles of rotation
radioisotopes	radioactive isotopes of an element
radiopharmaceuticals	radioactive substances used in the treatment of medical conditions
rarefactions	areas along a longitudinal wave where the medium is less dense or more spread apart than when at rest
raster	an array of pixels or cells to render an image
reactor core	that part of a nuclear reactor containing the fuel rods, moderator and control rods in which heat is generated by the fission of the fuel
real-time ultrasound image	an image which can be viewed as it is being taken
re-entry angle	the angle made with the upper atmosphere by the path of a returning spacecraft
relative velocity	the velocity of one object relative to another found using vector subtraction
relativistic velocity	speeds at which the special theory of relativity will predict noticeable changes in observations of the length, time and mass of the moving object
repetition time (TR)	the time between repeated pulses of radio frequency energy in MRI procedures
resistance	the extent to which a conductor resists the flow of an electric current given by Ohm's law: $R = \frac{V}{I}$
resolving power	the ability of a telescope or optical device to separate objects which appear close together
rest length	the length of an object measured when it is at rest
rest or original time	the time interval passing on an object measured when it is at rest
reverse biased	when the positive terminal is connected to the n-type side of a diode so that no current can flow
right-hand palm rule	the fingers of the right hand represent the lines of magnetic force, the thumb the direction of motion of either positive charge or conventional current and the palm represents the direction of the force acting on the moving charge or on the current-carrying conductor
rise over run	the difference in y-axis values divided by the difference in x-axis values giving the gradient between two points (usually on a straight line)
rotor	the rotating part of an electric motor or generator
Rydberg's constant	used in the Rydberg equation as the constant value
secondary coil	the coil in a transformer connected to the device to be powered or having the secondary voltage after stepping up or down
secondary coolant	the substance used to cool extract heat away from the primary coolant in a nuclear power station
seeing	the blurring and distortion of images from space caused by Earth's atmosphere
semiconductor	a substance having electrical resistivity between that of a metal and a non-metal including germanium and silicon
sensitivity	the light collecting ability of a telescope proportional to the surface area of the light collecting mirror or lens
shadow mask	a screen used in cathode ray tubes that allows electrons only from the correct electron gun to strike the correct phosphors on the screen

silicon	an abundant element in Earth's crust being the element with atomic number 14 used widely as a semiconductor
slip ring commutator	device used in AC motors and generators to connect the rotor coils to the power supply or to the external circuit
soft iron core	the core of a transformer made from iron with a high magnetic permeability
soft X-ray	X-rays with lower frequency/longer wavelength with less penetrating power than hard X-rays
solenoid	a coil of wire that can be used to produce an electromagnet
solid state diode	an electronic device made from semiconducting materials for the purpose of allowing the flow of current in one direction only
special relativity	relativity as outlined in Einstein's special theory of relativity relating particularly to length contraction, time dilation and mass dilation
spectroscope	an instrument used to separate the light from a source into its spectrum
spin-lattice relaxation (T1)	in MRI, the time taken for the spins of the nuclei to give their added energy from the RF pulse back to the lattice
spin-spin relaxation time (T2)	the time taken for the transverse magnetic signal to reach 37% of its initial value
split ring commutator	a metal ring made from two separate halves connected to the brushes in a DC motor or generator two connect the rotor coils to the power supply or to the external circuit
squirrel cage	the rotor in an induction motor so named as it resembles the shape of a squirrel cage (or mouse cage)
starting resistance	a resistance applied to large motors upon start-up when back EMF is small to prevent excess current flowing in the coils of the motor
stator	the stationary part of a motor or generator that does not rotate, usually the magnets in small units
stopping voltage	the minimum voltage required to stop the photocurrent in a photoelectric effect circuit which provide the value of the maximum kinetic energy of the photoelectrons
strong nuclear force	one of the four fundamental forces in nature that acts over a very small distance within the nucleus that holds the nucleons together
superconductivity	the state in which a substance presents no resistance to the flow of electric current
superconductor	a substance that presents no resistance to the flow of electric current
switch	a mechanical or electronic device that controls the flow of electric current
symmetrical	having one side the mirror image of the other
thermionic device	a vacuum tube designed to perform an electronic function such as a diode or triode (transistor equivalent)
thermionic effect	the release of electrons from a heated cathode in a thermionic device
thermionic emission	the flow or release of electrons due to their heat energy, usually from a cathode in a thermionic device
thought experiment	an experiment which would be difficult or impossible to perform but can be imagined to occur as used by Einstein in his descriptions and explanations of relativity
threshold frequency	the minimum frequency required for incident light to be able to produce photoelectrons; a value characteristic of each metal
time of flight	the time that a projectile remains in the air
torque	a rotational force being the product of the tangential force and the perpendicular distance from the fulcrum or turning point
trajectory	the path taken by a projectile
transformer	a device that changes the voltage of an AC power source
transistor	a solid state device having three connections comprising two p-n junctions that performs the roles of either amplifier or switch in electronic circuits
transuranic element	any of the artificially produced elements with an atomic number greater than uranium ($Z > 92$)
transverse magnetisation	The xy component of the net magnetisation vector at right angles to the main magnetic field.
triode valve	a thermionic device used to amplify an electric signal
uncertainty principle	also 'Heisenberg uncertainty principle': in quantum physics, that certain pairs of values of a particle such as its simultaneous position and momentum cannot be both known precisely but can only be known with set uncertainty
uniform circular motion	circular motion undertaken by an object with constant speed

valence band	the energy level range of electrons that have the highest energies in the atom (i.e. outer shell electrons)
valence electrons	electrons that have the highest energies in the atom, i.e. outer shell electrons that are involved in chemical bonding
valence shell	the outermost shell of electrons in an atom
waveband	a range of wavelengths of electromagnetic radiation within the entire spectrum forming a portion having similar properties and uses (e.g. radio, UV, light etc)
wavelength	the distance between two successive corresponding points on a wave (e.g. crest to crest)
wave-particle duality	the description applied to the nature of light which has both a wave nature and a particle nature
waves	an oscillating disturbance that propagates without transferring the medium (for mechanical waves) but transfers energy from one place to another
weak nuclear force	one of the four fundamental forces in nature which acts over very small distances within the nucleus; one of its effect is to cause beta decay
work function	the minimum energy required to remove an electron (photoelectron) from the surface being illuminated
x-intercept	the point on a graph where the plotted function crosses the x axis
X-ray tube	a vacuum tube used to produce X-rays consisting of a cathode as the source of electrons and an anode as the target from which the suddenly decelerated electrons emit X-rays
y-intercept	the point on a graph where the plotted function crosses the y axis
Zeeman effect	the splitting of a spectral line when the source is subjected to a magnetic field