Department of Electrical Engineering
Assignment
Date: 22/06/2020

Course Details

Course Title: Thermodynamics **Module:** 02
Instructor: **sir Mujtaba Ihsan** **Total Marks:** 50

Student Details

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Q1.	(a) i. ii. (b)	**State** the following along with their mathematical expressions: The ideal gas law Dalton's law of partial pressure **Explain** the Carnot cycle.	Marks 04+06 CLO 2
Q2.	(a) (b)	You need to buy a refrigerator for your home. **Outline** the key factors that you will consider while buying the refrigerator. **Explain** vapour absorption refrigeration system.	Marks 05+08 CLO 3
Q3.		**Distinguish** between water tube & fire tube boilers.	Marks 06 CLO 3
Q4.		State the meaning of the word "stroke" & **describe** the working of a 04 stroke engine.	Marks 12 CLO 3
Q5.	(a) (b)	**Outline** the differences between a petrol engine & a diesel engine. Several provincial governments in Pakistan have banned the use of 02 stroke engines in auto rickshaws**. Identify** the causes behind this decision.	Marks 04+05 CLO 3

Answer no 1:

Part (a),

Ideal gas law

An ideal gas is a theoretical gas! It does not exist in reality but is assumed to exist for the purpose of simplifying calculations. It also generates a reference point in relation to which the behavior of other gases can be studied. An ideal gas is defined as a gas composed of randomly moving particles as all gases do, the only difference being that for an ideal gas when its particles collide with each other, these collisions are assumed to be perfectly elastic which means no energy of either of these particles is wasted. In reality, however, when actual gas particles collide with each other, some of their energy is wasted in changing directions and overcoming friction. However, at STP (standard temperature and pressure) conditions most natural gases act just like an ideal gas.

The laws which deal with ideal gases naturally called ideal gas laws and the laws determined the observational work of Boyle in the seventeenth century, Charles in the eighteenth century and Avogadro.

Ideal gas equation:

The combined equations of four variable i.e volume, pressure, temperature and number of moles of gas known as ideal gas equation.

Its derived from Boyles Law , Charles Law and Avogadro's Law

According to Boyles Law –the volume of given mass of gas is inversely proportional to the applied pressure at a constant temperature and moles.

$V \propto \frac{1}{p}$,,,,,,,,,,,,,,,,,,(1)

Charles Law – states that for a given fixed mass of gas at a constant pressure the gas volume is directly proportional to the gas temperature.

$V \propto T$,,,,,,,,,,,,,,,(2)

Avogadro's Law –state that the volume of gas at constant temperature and pressure is directly proportional to number of moles.

$V \propto n$,,,,,,,,,,,,,(3)

From above 3 equations

$V \propto \frac{1}{P} \times T \times n$

$V = R\frac{T}{P}n$

R is know as universal gas constant or general gas constant

V P = RTn

PV = n R T

P V = nRT,,,,,,,,,,,,,,,(*)

Above equation * is known as ideal gas equation

At STP n=1

P V =RT

$\frac{PV}{T}$ =R

For initial state

$\frac{P1V1}{T1}$ =R

For final state

$\frac{P2V2}{T2}$ =R

Compare 2 value of R

$\frac{\boldsymbol{P1V1}}{\boldsymbol{T1}} = \frac{\boldsymbol{P2V2}}{\boldsymbol{T2}}$ **generalized form of ideal gasequation**

Part (b)

Dalton's law of partial pressure

In 1801 John Dalton studies the mixture of gases and concluded from his experiment that when a mixture of gases is enclosed in a container each gas exerts the same pressure as it would exerts if it occupied the volume of container alone at the same temperature

According to Dalton law of partial pressure the total pressure of mixture of gas in container is the sum of partial pressure all the gases present in it.

P = P1 + P2 + P3 +………… Above equation is mathematical form of Dalton's law

Partial pressure is the pressure of gas mixture while total pressure of the mixture is the sum of these partial pressure.

Part (c)

Carnot cycle

A cycles of heat engine is completed when the properties of system have returned to the original state the operation cycles of the most efficient engine (Carnot engine) is called Carnot cycles its consist of four processes two isothermal and two adiabatic processes.

Isothermal expansion

Heat from the source is supplied to the working substance in the cylinder. This causes the substance to expand from V1 to V2 and hence to perform work on the surroundings. The internal energy of the gas increases by an amount Q1. However, since the cylinder is open at this stage the temperature remains constant at T1 the expansion is thus termed isothermal.

Adiabatic expansion

The cylinder is then sealed and perfectly insulated so no further heat is supplied or lost from the working substance. The substance continues to expand adiabatically, that is, energy is not lost or gained from the system during this stage. The volume increases from V2 to V3 resulting in a fall in temperature from T1 to T2

Isothermal compression

The surroundings now work on the system, acting to cause the piston to compress the gas from V3 to V4. Since the cylinder is once again open, energy Q2 is exhausted to the sink isothermally at T2

Adiabatic expansion

Finally, the cylinder is sealed once more and the surroundings continue to work on the working substance compressing it further from V4 to V1 with there being no exchange in energy, thus returning it to the starting temperature T1

the efficiency of thermal efficiency (n) is given by

Efficiency = $\frac{out\ put}{-input} = \frac{work\ ob\ tain}{heat\ supplied}$

n = $\frac{\Delta W}{Q1}$

n = $\frac{\mathrm{Q1-Q2}}{Q1}$

$n = 1 - \frac{Q2}{Q1}$,,,,,,,,,,(a)

aswe know that

$\frac{Q2}{Q1} = \frac{T2}{T1}$

Put in a'

$n = \frac{T1 - T2}{T1}$

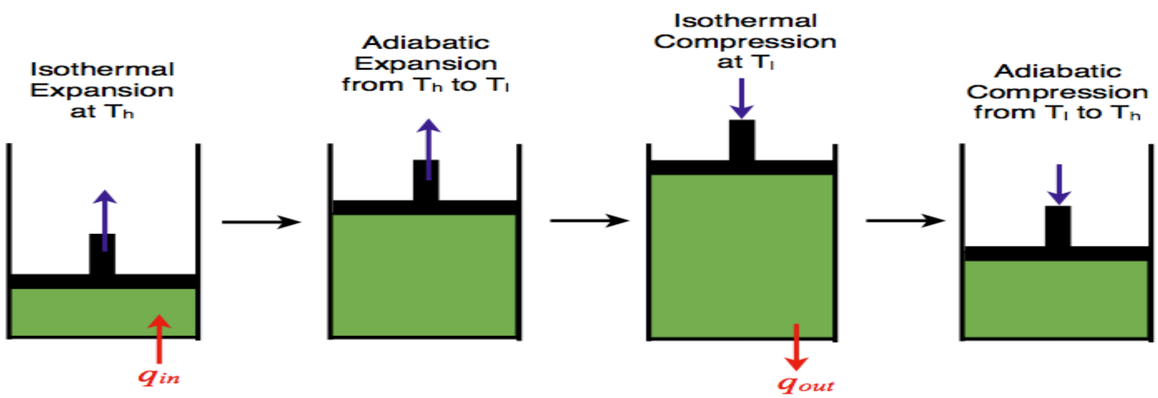
$n = 1 - \frac{T2}{T1}$

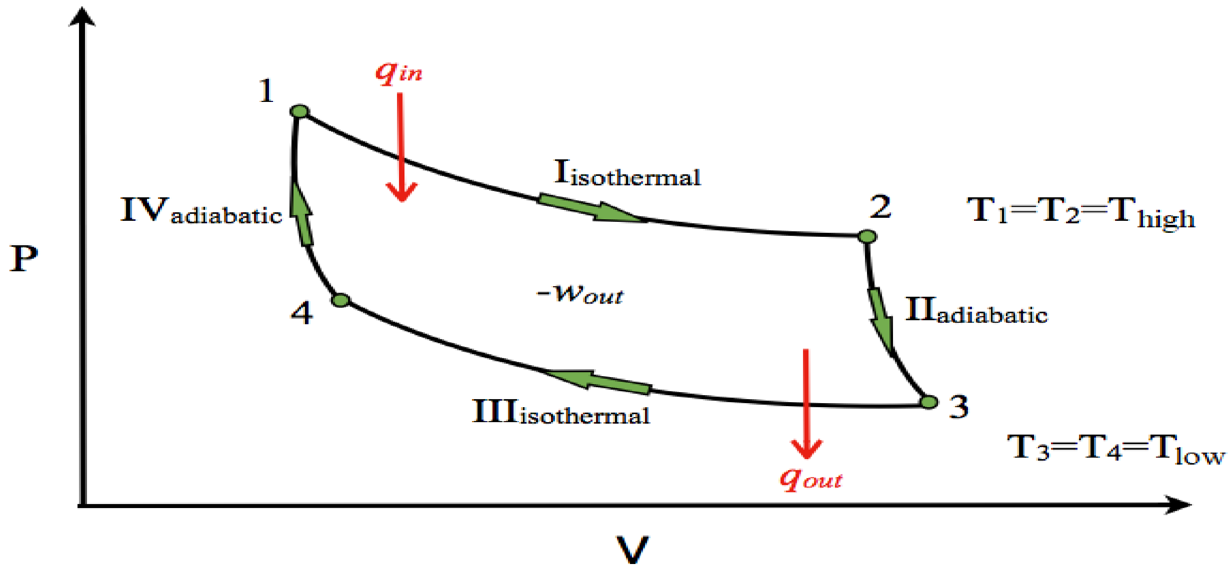
thus the efficiency of Carnot engine depend up on high temperature and low temperature reservoirs and nature of working substance .if we take low temperature reservoir as 0k

$n = 1 - \frac{T2}{0}$

n= 1 or 100% efficient

which mean work done by Carnot engine is equal to Q1 i.e all heat supplied is used in doing work with out transfer heat to atmosphere which is not possible carnot engine is an ideal engine mover ever the efficacy of heat engine is always less then 100.





Answer no 2:

Part (a)

The key factors will consider while buying the refrigerator.

Styles

Modern fridges come in a variety of layouts. The most common styles are side-by-side, freezer-on-top, or freezer-on-bottom models. Each one has benefits and drawbacks to consider. Side-by-side models have smaller doors that take up less floor space when opened, but they also donnot fit wide items, such as frozen pizza boxes. Traditional refrigerators with freezers on top are often priced lower than other options but are not as attractive. Bottom-freezer options are convenient because the refrigerated compartment is easily accessible and at eye level.

Refrigerator Features

New refrigerator features add value and convenience. They also tend to come at a higher price tag. You will want to consider which features are important to you. Adjustable shelves allow you to customize your space. In-door water and ice dispensers are popular with many people. Some models offer special temperature-controlled drawers to keep certain foods fresher.

Energy Efficiency

Newer refrigerators use less energy, which translates into savings for you and less environmental impact. Look for refrigerators that are ENERGY STAR certified. These models comply with stricter efficiency guidelines, which can save you up to $300 on your energy bills over the lifetime of your appliance while decreasing greenhouse gas emissions.

Related – Help Your Refrigeration Keep Its Cool

Dimensions

All the features in the world mean nothing if the refrigerator doesn't fit in your space. Most fridges sit between two counters, so make sure you measure the width. You'll also want to look at the depth of the appliance and its door swing. If your spot lacks depth or you have an island, you may want to go with a counter-depth model. Keep in mind that your new refrigerator also will have to fit through all doorways on the way to its new home.

Finish

Options for finishes seem to grow every year. Stainless steel is still popular, especially since the advent of new smudge-resistant versions. But newer options, including black stainless and bronze, are growing in appeal. In addition to these newer finishes, lower-priced classic white and black finishes are attractive in some kitchens. For a high-end look, some built-in models can be customized to blend with your cabinets.

Part (b)

Vapor absorption refrigeration

The vapor absorption refrigeration system comprises of all the processes in the vapor compression refrigeration system like compression, condensation, expansion and evaporation. In the vapor absorption system the refrigerant used is ammonia, water or lithium bromide. The refrigerant gets condensed in the condenser and it gets evaporated in the evaporator. The refrigerant produces cooling effect in the evaporator and releases the heat to the atmosphere as the condenser. major difference between the vapor compression and vapor absorption cycle is the method in which the energy input is given to the system. In the vapor compression system the energy input is given in the form of the mechanical work from the electric motor run by the electricity. In the vapor absorption system the energy input is given in the form of the heat. This heat can be from the excess steam from the process or the hot water. The heat can also be created by other sources like natural gas, kerosene, heater etc. though these sources are used only in the small systems.

Principle of working

Heat energy is utilized to achieve the refrigeration. An electric heater or steam isused to add the heat to the refrigerant for its evaporation. Also an absorber, a pump and a generator are used to complete the cycle

Working

Dry ammonia vapor from the evaporator enters the absorber containing water where it is absorbed by the water becomes a strong ammonia solution with an increase in temperature. The heat generated during this process is removed to some extent by circulating cold water through a pipe. Otherwise absorbing capacity reduces with hot water. The strong ammonia solution is now pumped by a pump to the generator where it is heated by an electric coil. As result ammonia vaporizes and separates out from the water. It is then driven out from the solution to the condenser where it is condensed and return to the liquid state. The liquid ammonia is then collected in the receiver. The high pressure liquid ammonia is then passed through the throttle valve where it is expanded with decrease in temperature and pressure. Later it enters the evaporator kept in the storage room.

Answer no 3:

Boiler:

A boiler is a closed vessel in which fluid (generally water) is heated up to high-pressure steam. The boilers are used in power plants, for the generation of steam. They are mostly used in power plants where steam turbines are used for the generation of electricity.

Fire-tube boiler:

Fire-tube boiler is those boiler in which the fire or hot gas is present inside the tubes and water surrounds these fire tubes. Since fire is inside the tubes and hence it is named as fire tube boiler. The heat from the hot gases is conducted through the walls of the tube to the water. The examples of the fire tube boiler are the simple vertical, Cochran, Scotch marine, and Velcon boiler.

Water-tube boiler:

The water-tube boiler is those boiler in which the water is present inside the tubes and fire or hot gases surround these fire tubes and heat transfer from hot gas to water through tube walls . The examples of water tube boilers are a La-Mont, Benson, Stirling, Babcock and Wilcox, Yarrow and Loeffler boiler.

Fire-tube boiler:	**Water-tube boiler**
Hot flue gases flow inside the tube and the water outsides the tubes.	Water flows inside the turbine and hot flue gases outside the tube
These boilers are generally internally fired	These boilers are generally externally fired.
The boiler pressure limited to 20 bar.	The boiler pressure is limited to up to 100 bar
The fire-tube boiler has a lower rate of steam production.	A higher rate of steam production.

Involves lesser risk of explosion due to low pressure	the risk of the explosion is higher due to high boiler pressure

Answer No 4 :

Stoke

Stoke is movement of pistons from top dead center (TDC) to bottom dead center (BDC).

Four stoke engine

A four-stroke engine (also known as four-cycle) is an internal combustion engine in which the piston completes four separate strokes which comprise a single thermodynamic cycle. A stroke refers to the full travel of the piston along the cylinder, in either direction. Four stroke cycle engine is working at completed four stroke of the piston or two revaluation of the crank shaft it is called as four stroke engine. The four stoke of otto cycle engine are

Intake Stroke

The intake event is when the air-fuel mixture is introduced to fill the combustion chamber. The intake event occurs when the piston moves from TDC to BDC and the intake valve is open. The movement of the piston toward BDC creates a low pressure in the cylinder. Ambient atmospheric pressure forces the air-fuel mixture through the open intake valve into the cylinder to fill the low pressure area created by the piston movement. The cylinder continues to fill slightly past BDC as the air-fuel mixture continues to flow by its own inertia while the piston begins to change direction. The intake valve remains open a few degrees of crankshaft rotation after BDC. Depending on engine design. The intake valve then closes and the air-fuel mixture is sealed inside the cylinder.

Compression Stroke

The compression stroke is when the trapped air-fuel mixture is compressed inside the cylinder. The combustion chamber is sealed to form the charge. The charge is the volume of compressed air-fuel mixture trapped inside the combustion chamber ready for ignition. Compressing the air-fuel mixture allows more energy to be released when the charge is ignited. Intake and exhaust valves must be closed to ensure that the cylinder is sealed to provide compression. Compression is the process of reducing or squeezing a charge from a large volume to a smaller volume in the combustion chamber. The flywheel helps to maintain the momentum necessary to compress the charge.When the piston of an engine compresses the charge, an increase in compressive force supplied by work being done by the piston causes heat to be generated. The compression and heating of the air-fuel vapor in the charge results in an increase in charge temperature and an increase in fuel vaporization. The increase in charge temperature occurs uniformly throughout the combustion chamber to produce faster combustion (fuel oxidation) after ignition.The increase in fuel vaporization occurs as small droplets of fuel become vaporized more completely from the heat generated.

The increased droplet surface area exposed to the ignition flame allows more complete burning of the charge in the combustion chamber. Only gasoline vapor ignites. An increase in droplet surface area allows gasoline to release more vapor rather than remaining a liquid. The more the charge vapor molecules are compressed, the more energy obtained from the combustion process. The energy needed to compress the charge is substantially less than the gain in force produced during the combustion process. For example, in a typical small engine, energy required to compress the charge is only one-fourth the amount of energy produced during combustion. The compression ratio of an engine is a comparison of the volume of the combustion chamber with the piston at BDC to the volume of the combustion chamber with the piston at TDC. This area, combined with the design and style of combustion chamber, determines the compression ratio. Gasoline engines commonly have a compression ratio ranging from 6:1 - 10:1. The higher the compression ratio, the more fuel-efficient the engine. A higher compression ratio normally provides a substantial gain in combustion pressure or force on the piston. However, higher compression ratios increase operator effort required to start the engine. Some small engines feature a system to relieve pressure during the compression stroke to reduce operator effort required when starting the engine.

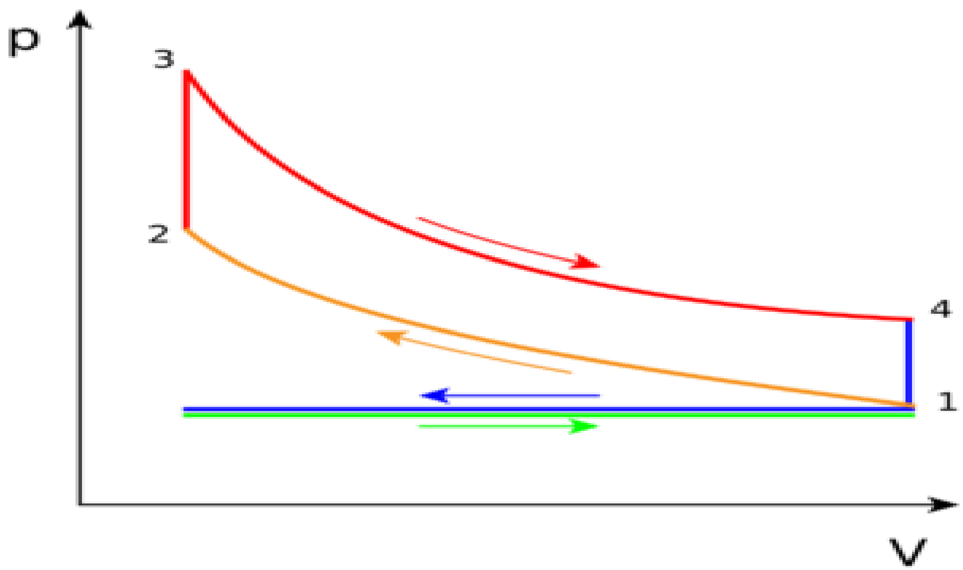
Power Stroke

The power stroke is an engine operation Stroke in which hot expanding gases force the piston head away from the cylinder head. Piston force and subsequent motion are transferred through the connecting rod to apply torque to the crankshaft. The torque applied initiates crankshaft rotation. The amount of torque produced is determined by the pressure on the piston, the size of the piston, and the throw of the engine. During the power Stroke, both valves are closed.

Exhaust Stroke

The exhaust stroke occurs when spent gases are expelled from the combustion chamber and released to the atmosphere. The exhaust stroke is the final stroke and occurs when the exhaust valve is open and the intake valve is closed. Piston movement evacuates exhaust gases to the atmosphere. As the piston reaches BDC during the power stroke combustion is complete and the cylinder is filled with exhaust gases. The exhaust valve opens, and inertia of the flywheel and other moving parts push the piston back to TDC, forcing the exhaust gases out through the open exhaust valve. At the end of the exhaust stroke, the piston is at TDC and one operating cycle has been completed.

Graph of otto cycle



Answer 5:

Part (a)

Differences between a petrol engine and a diesel engine

Petrol Engine

Petrol engines are internal combustion engines which have spark-ignition. They run on relatively volatile fuels such as petrol. In these engines, air and fuel are generally mixed post-compression. Petrol engines work on the Otto cycle, which consists of two isochoric processes and two isentropic processes. In petrol engines, air and petrol are usually mixed in a carburettor before being introduced to the cylinder.Once the air and petrol are compressed, the fuel is ignited via an electric spark.

Diesel Engine

The Diesel engine is also an internal combustion engine which is also known as the compression-ignition engine. It is named after Rudolf Diesel.

In these engines, the fuel is injected into a combustion chamber and is then ignited by the high temperature of the air in the chamber. The high temperature of the air in the cylinder is due to the adiabatic compression. These engines only compress the air and not the fuel. When injected into the combustion chamber, the Diesel fuel undergoes spontaneous ignition. These engines work on the Diesel cycle, which consists of a constant pressure process, a constant volume process, and two isentropic processes.

Diesel Engine	**Petrol Engine**
These engines work on the Diesel cycle	These engines work on the Diesel cycle
The fuel is mixed with air inside the cylinder	Air and the fuel are mixed in a carburettor
Ignition is achieved with the help of the hot, compressed air	Fuel is ignited with an electric spark
High power production	Relatively low amounts of power are produced in a Petrol engine
Generally used in heavy vehicles such as trucks and buses	Used in light vehicles such as motorcycles and cars
High initial and maintenance costs	Comparatively low initial cost and maintenance cost

Part (b)

The motorcycles and rickshaws, due to being equipped with 2-stroke engines, are the most inefficient vehicles in complete burning of fuel and thus contribute most to emission of air pollutants in the environment. The major pollutants from two-stroke engines are Carbon Monoxide (CO), Nitrogen Oxides (NOx), Hydrocarbons (HC) and Particulate Matter (PM). Their presence in the environment causes a number of respiratory diseases and other illnesses. For example, CO and NOx are notorious irritants of respiratory system and have potential suffocating action. PM causes premature death, and illness. Its presence is accompanied by increased hospital admissions for asthma and other bronchial conditions such as bronchitis, etc. None of the locally assembled rickshaws meets standards fixed by Pakistan Standards Quality Control Authority (PSQCA) for smoke emission. According to the PSQCA code, two-stroke exhaust contains 4.5 per cent and old two-stroke has six percent carbon mono oxide. Due to executing huge amount of pollution Pakistan GOVT banned 2 stoke engine.