

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

Course Details

Course Title: Thermodynamics **Module:** 02
Instructor: _____ **Total Marks:** 50

Student Details

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Q1.	(a)	State the following along with their mathematical expressions: i. The ideal gas law ii. Dalton's law of partial pressure	Marks 04+06
			CLO 2
Q2.	(a)	You need to buy a refrigerator for your home. Outline the key factors that you will consider while buying the refrigerator.	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)	Outline the differences between a petrol engine & a diesel engine.	Marks 04+05
			CLO 3
	(b)	Several provincial governments in Pakistan have banned the use of 02 stroke engines in auto rickshaws. Identify the causes behind this decision.	

Q1

(a)

(i) ideal gas law:

statement:

A gas that would obey Boyle's, Charles's law and Avogadro's Law (all four laws) under the conditions of temperature and pressure is called an ideal gas law.

Here, we combine four measurable variables P , V , T and n to give a single equation

The combined gas law can be written as

$$V \propto nT/P$$

$$\text{or } PV \propto nT$$

$$\boxed{PV = nRT}$$

This equation is called ideal gas equation

where R is the constant of proportionality -r universal gas constant.

$$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$R = 0.0821 \text{ litre atm K}^{-1} \text{ mol}^{-1}$$

$$R = 2 \text{ cal K}^{-1} \text{ mol}^{-1}$$

(ii) Dalton's law of partial pressures:

Statement :

At constant temperature, the pressure exerted by a mixture of two or more non-reacting gases enclosed in a definite volume, is equal to the sum of the individual pressures which each gas ~~is~~ would exert if present alone in the same volume.

Mathematically :

If P is the total pressure of the mixture of ~~the~~ non-reacting gases at temperature T and volume V , and P_A, P_B, P_C, \dots represent the partial pressures of the gases, then

$$P_T = P_A + P_B + P_C$$

Q1

(b)

Carnot cycle:

Definition:-

A Carnot cycle is defined as an ideal reversible closed thermodynamic cycle in which there are four successive operations involved and they are isothermal expansion, adiabatic expansion, isothermal compression and adiabatic compression. During these operations, the expansion and compression of substance can be done up to desired point and back to initial state.

Following are the four processes of Carnot cycle:

⇒ • In (a), the process is reversible isothermal gas expansion. In this process, the amount of heat absorbed by the ideal gas is q_{in} from the heat source which is at a temperature of T_h . The gas expands and does work on the surroundings.

⇒ • In (b), the process is reversible adiabatic gas expansion. Here, the system is thermally insulated

and the gas continues to expand and work is done on the surroundings. Now the temperature is lower, T_1 .

⇒ • In (c), the process is reversible isothermal gas compression process. Here, the heat loss, q_{out} occurs when the surroundings do the work at temperature T_1 .

⇒ • In (d), the process is reversible adiabatic gas compression. Again the system is thermally insulated. The temperature again rises back to T_h as the surrounding continue to do their work on the gas.

Isothermal expansion at T_h

Adiabatic expansion from T_h to T_1

Isothermal compression at T_1

Adiabatic compression from T_1 to T_h



(a) ↑ q_{in}



(b)



(c) ↓ q_{out}



(d)

Q2
(a)

The below point are considered when you buying the refrigerator for home.

- ① over all capacity
- ② Refrigerator type

- single door
- Double door
- Triple door
- side by side
- French door Bottom mount

- ③ Refrigerants

check the refrigerant that which refrigerant are used.

- ④ Compressor

check the capacity of compressor.

- ⑤ check the pipes in ~~condenser~~ condenser for coating method

- ⑥ Defrosting type

- Direct cool
- Frost cool

→ ~~power~~

⑥ power consumption

less power consumption is better for refrigerator.

⑦ features

→ Energy efficient needs less power to cool instantly.

→ cools interiors and materials faster than others.

→ is cheaper than frost free refrigerators.

→ large sections for fridge and freezer.

→ large capacity from 500 to 800 ltr

→ suitable for large families

→ saves energy

Q2

(b)

VAPOUR ABSORPTION REFRIGERATION:

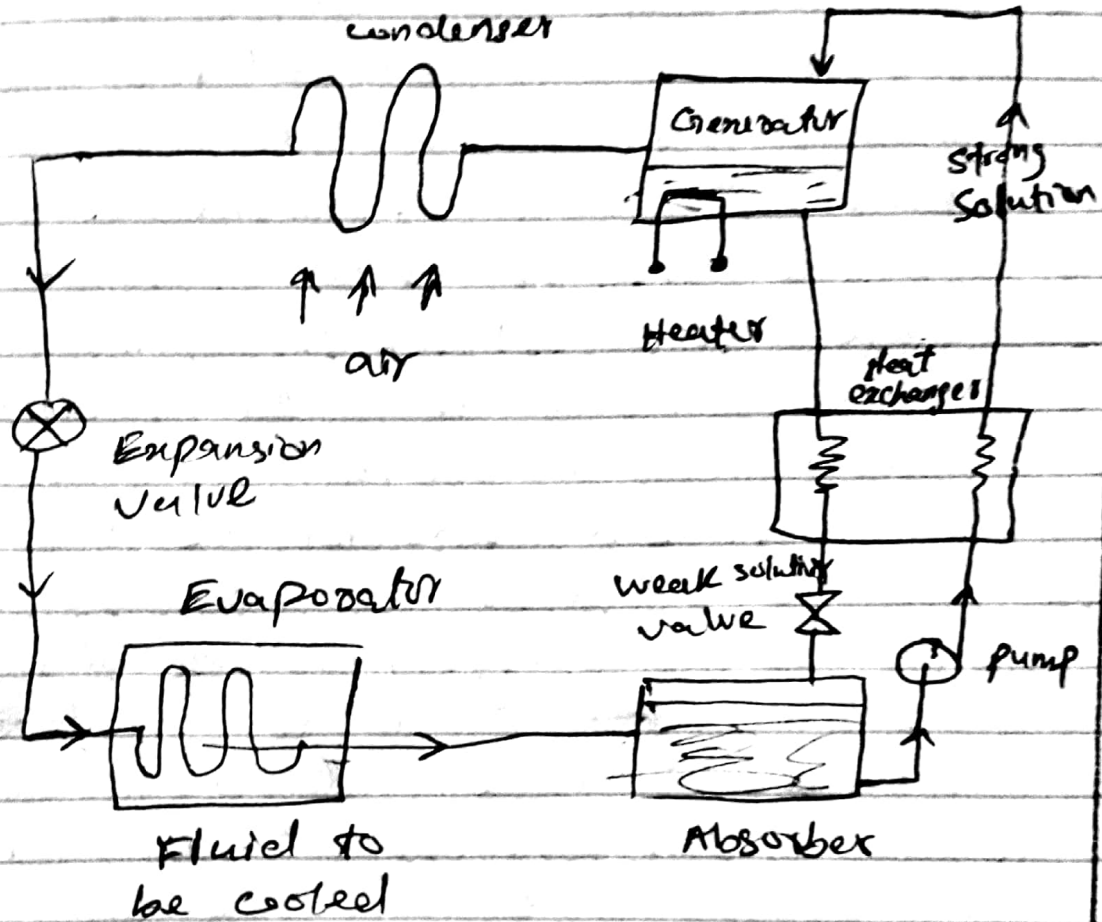
Principle:

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

Construction

Here a throttle valve is connected b/w an evaporator and a condenser. One pump is connected b/w an absorber and a separator. Water is filled in the absorber and it is connected to the evaporator. The evaporator is kept in the storage ~~room~~ room. The separator is connected to the condenser. Both the condenser and evaporator consists of pipes in coil form to provide more contact surface area for the refrigerant. Arguments are made to circulate the cold water around the condenser and in the absorber. An electric heater is housed in the separator. Trays may be positioned

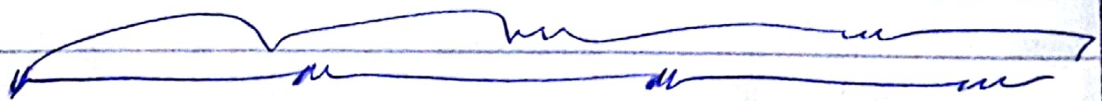
to collect the exit water near by the absorber and condenser. A receiver is connected in b/w the condenser and the throttle valve.



Working:

Dry ammonia vapour 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 a 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~~ ~~than pass of through the~~ ~~the~~ pressure. Later it enters the evaporator kept in the storage room.



Q3

water tube Vs fire tube boiler

→ In Fire-tube boiler hot flue gases pass through tubes and water surrounds them, while in water-tube boilers water passes through tubes and hot flue gases surround them

→ ~~FTB~~ FTB are operated at low pressures up to 20 bars while WTB working pressure is high enough up to 250 bars.

→ In FTB the rate of steam generation and quality of steam are very low therefore, not suitable for power generation while ~~in~~ in WTB the rate of steam generation and quality of steam are better and suitable for power generation.

→ FTB load fluctuations cannot be handled while in WTB load fluctuations can be easily handled.

→ It required more floor area for a given output while WTB requires less floor area for a given output.

→ Fire-tube boiler are used in process industry while water-tube boiler are used in large power plants.

Q4

Stroke:

The stroke of an engine means the completion of the piston movement in cylinder from TDC (TOP dead centre) to BDC (Bottom dead centre) of cylinder.
or

Stroke also means the distance travelled by the piston.

4 stroke engine

A four-stroke cycle engine is an internal combustion engine that utilizes four distinct piston strokes (intake, compression, power, and exhaust) to complete one operating cycle. The piston makes two complete passes in the cylinder to complete one operating cycle.

An operating cycle requires two revolutions (720°) of the crankshaft.

The four-stroke cycle engine is the most common type of small engine.

A four-stroke cycle engine completes five strokes in one operating cycle including intake, compression, ignition, power, and exhaust strokes.

① INTAKE STROKE:

On the intake stroke, the piston is moving down due to which a partial vacuum is produced inside the cylinder. The intake valve is open, therefore, atmospheric pressure pushes the fresh air fuel mixture in the cylinder through the intake valve.

② Compression Stroke:

When the piston reaches the B.P.C on the intake stroke, the intake valve closes. Then the piston moves up on the compression stroke.

During this stroke, both the valves are closed, therefore, no air-fuel mixture can enter or ~~gases~~ goes out of the cylinder. Therefore, when the piston moves up the mixture inside the cylinder is compressed. In modern engine, it is compressed to one-eighth or one-ninth of the original volume.

The amount to which the air-fuel mixture is compressed is called "the compression ratio".

If the mixture is compressed to one-eighth of the original volume, the compression ratio is "8" to "1"

(8:1)

③ Power Stroke:

During the compression stroke, the piston moves up when it gets near T.D.C, the spark plug produces a spark which ignites the compressed air-fuel mixture. Due to which the temperature and the pressure of gas rises. The pressure becomes about 600psi which push the piston down. As during this stroke, we obtain power therefore it is called "power stroke".

The piston transmit this power through the connecting rod to the crank due to which the crankshaft rotates. This rotatory motion is carried through shafts and gears to the car wheels due to which wheel turns and car moves.

④ Exhaust Stroke:

During the power stroke as the piston reaches B.D.C, the exhaust valve opens. Then the piston moves up on exhaust stroke when the piston moves up, pushes out the burnt gases from the cylinder through exhaust valve. when the piston reaches T.D.C, the exhaust valve closes and intake valve opens for the second cycle.

~~expands for the second cycle.~~

Compression Ratio:

The volume in which piston reciprocates i.e. the volume from B.D.C to T.D.C is called (swept volume " V_s ")

The volume in which fresh air fuel mixture is compressed by the piston in the cylinder is called clearance volume " V_c "

Thus the total volume of the cylinder is the sum of the swept volume and clearance volume

$$V_T = V_s + V_c$$

And the compression ratio is the ratio of the total volume to the clearance volume.

$$\text{compression ratio} = \frac{\text{Total volume}}{\text{clearance vol}}$$

$$= \frac{V_T}{V_c}$$

Opening & closing of valves in Four Stroke Engine :

The opening and closing operation of valves is done with camshaft. The camshaft has a lobe, so as the camshaft rotates and the lobe comes under the valve lifter it pushes the push rod up due to which one open ~~end~~ end of ~~rod~~ rocker arm moves up while the other (valve end) moves down like see-saw, which pushes the valve down i.e opens the valve. The valve stem has a spring which is called "valve spring", which closes the valves.

Q5
(a)

petrol engine vs 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.

→ Relatively low compression ratio

→ Low power produced

→ High fuel consumption

→ low initial and maintenance cost

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 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.

→ The fuel is mixed with air inside the cylinder.

→ High compression ratio.

→ High power production

→ Low fuel consumption

→ High initial and maintenance costs

Q5
(b)

In our computations, there was almost complete consensus on imposing the ban as all the parties accepted that two-stroke engine rickshaws, being source of injurious air pollutants to human and animal health, were contrary to the national health security. The major point made in favour particularly by the manufacturers for total justification of the ban was that the two-stroke rickshaw technology is obsolete and two-strokes have been banned all over the world not only in Pakistan. Being very old, they are highly noisy, and emit poisonous pollutants such as CO, carbon dioxide, oxides of nitrogen, sulfur dioxide, particulates such as PM10, PM2.5, etc.

Reasons:

The two stroke engines Rickshaws ~~produce~~ produce large amount of pollution and noise.