MOHAMED SATHAK A J COLLEGE OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

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EPC Questions – PART A

UNIT I

1. Should the automobile radiator be analyzed as a closed system or as an open system? Explain. (Nov/Dec 2016)

Automobile radiator system is analyzed as closed system. In this no mass (water) cross the boundary.

2. Define thermodynamic equilibrium. (Nov/Dec 2014) (May/June 2014)

If a system is in Mechanical, Thermal and Chemical Equilibrium then the system is in Thermodynamically equilibrium. (or) If the system is isolated from its surrounding there will be no change in the macroscopic property, thenthe system is said to exist in a state of thermodynamic equilibrium.

3. Name and explain the two types of properties. (Nov/Dec 2013)(Nov/Dec 2016)

The two types of properties are intensive property and extensive property. Intensive Property: It is independent of the mass of the system. Example: pressure, temperature, specific volume, specific energy, density. Extensive Property: It is dependent on the mass of the system. Example: Volume, energy. If the mass is increased the values of the extensive properties also Increase.

4. Define Zeroth law of Thermodynamics. (Nov/Dec 2014)

When two systems are separately in thermal equilibrium with a third system then they themselves is inthermal equilibrium with each other.

5. What are the limitations of first law of thermodynamics? (Nov/Dec 2012)

1. According to first law of thermodynamics heat and work are mutually convertible during any cycleof a closed system. But this law does not specify the possible conditions under which the heat isconverted into work.
2. According to the first law of thermodynamics it is impossible to transfer heat from lowertemperature to higher temperature.

3. It does not give any information regarding change of state or whether the process is possible or not. 4. The law does not specify the direction of heat and work.

6. What is meant by thermodynamic work?

It is the work done by the system when the energy transferred across the boundary of the system. It ismainly due to intensive property difference between the system and surroundings.

7. Why does free expansion have zero work transfer? (April/May 2015)

In free expansion there is no external force acting on the gas so that the energy given to the gas can be utilized to produce heat and to overcome the repulsions between the gases which does not happen in free expansion therefore there is no work transfer.

8. Distinguish between 'Macroscopic energy' and 'Microscopic energy'. (Nov/Dec 2012)

Statistical Thermodynamics is microscopic approach in which, the matter is assumed to be made of numerous individual molecules. Hence, it can be regarded as a branch of statistical mechanics dealing with the average behaviour of a large number of molecules. Classical thermodynamics is macroscopic approach. Here, the matter is considered to be a continuum without any concern to its atomic structure.

9. Show that the energy of an isolated system remains constant. (Nov/Dec 2015)

A system which does not exchange energy with its surroundings through work and heat interactions is called an isolated system. That is for an isolated system $dW = 0$ and $dQ=0$. The first law of thermodynamics gives $dE = dQ - dW$ Hence, for an isolated system, the first law of thermodynamics reduces to $dE = 0$ or $E2 = E1$. In other words, the energy of an isolated thermodynamic system remains constant

10. What are the conditions for steady flow process? (May/June 2013)

- No properties within the control volume change with time. That is mcv = constant Ecv = constant
- No properties change at the boundaries with time. Thus, the fluid properties at an inlet or exit will remain the sameduring the whole process.

- They can be different at different opens. The heat and work interactions between a steady-flow system and its surroundings do not change with time.

11. Define the term enthalpy?

The Combination of internal energy and flow energy is known as enthalpy of the system. It may alsobe defined as the total heat of the substance. Mathematically, enthalpy (H) = U + pv KJ) Where, U – internal energy p – Pressure v – Volume In terms of Cp& T → H = mCp (T2-T1) KJ

12. Define the term internal energy

Internal energy of a gas is the energy stored in a gas due to its molecular interactions. It is also definedas the energy possessed by a gas at a given temperature.

UNIT II

1.Define Clausius statement. (Nov/Dec 2013)

It is impossible for a self-acting machine working in a cyclic process, to transfer heat from a body atlower temperature to a body at a higher temperature without the aid of an external agency

2.What is Perpetual motion machine of the second kind?

A heat engine, which converts whole of the heat energy into mechanical work is known as Perpetualmotion machine of the second kind.

3.Define Kelvin Planck Statement. (May/June 2014) (Nov/Dec 2014) (May/June 2013)

It is impossible to construct a heat engine to produce network in a complete cycle if it exchanges heatfrom a single reservoir at single fixed temperature

4.What is a reversed heat engine? (April/May 2015)

The reversed heat engine works on the principle of reversed Carnot cycle. The heat engine produces work by absorbing heat from source and liberating some heat to sink. The reversed heat engine transfers the heat from sink to the source with the help of external work

5. State Carnot theorem. (May/June 2014)

It states that no heat engine operating in a cycle between two constant temperature heat reservoir canbe more efficient than a reversible engine operating between the same reservoir

6. Explain entropy?(Nov/Dec 2014) (Nov/Dec 2015)

It is an important thermodynamic property of the substance. It is the measure of molecular disorder. Itis denoted by S. The measurement of change in entropy for reversible process is obtained by thequantity of heat received or rejected to absolute temperature.

7. Differentiate between a heat pump and refrigerator

Heat pump is a device which is operated in a cyclic process, maintains the temperature of a hot body at temperature higher that the temperature of surrounding. A refrigerator is a device which operating in a cycle process maintains the temperature of a cold body temperature lower than the temperature of the surrounding

8. Define the term COP.

Coefficient of performance is defined as the ratio of heat extracted or rejected to work input. Heat extracted rejected COP Work input

9. Why Carnot cycle cannot be realized in practice?

i) In a Carnot cycle all the four processes are reversible but in actual practice there is no process which is reversible.

ii) There are two processes to be carried out during compression and expansion. For isothermal process the piston moves very slowly and for adiabatic process the piston moves as fast as possible. This speed variation during the same stroke of the piston is not possible.

iii) It is not possible to avoid friction between moving parts completely

10. Why a Heat engine cannot have 100% efficiency?

Why a Heat engine cannot have 100% efficiency? BTL4 For all the heat engines there will be a heat loss between system and surroundings. Thereforethe entire heat input supplied to the engine cannot be converted into useful work.

11. Is the second law independent of first law? Explain.

Yes. The second law speaks about the quality of energy and the first law is based on energy interactions.

12. Define the terms source, sink and heat reservoir.(April/May2015)

Source: The part where the heat to be rejected to absorbing or work developing device is called Source.

Sink: The part which receives heat from work absorbing or working developing device is called Sink.

Reservoir: The part which supplies or receives heat continuously without change in its temperature is called as Reservoir..

UNIT III

1.Explain in short the principle of Increase of Entropy. (Nov/Dec17)

For any infinitesimal process undergone by a system, change in entropy, dS>dQ/T For reversible dQ = 0, hence, dS=0 For irreversible dS>0 So the entropy of an isolated system would never decrease. It will always increase and remains constant if the pressure is reversible is called as Principle of increase of Entropy.

2. Explain briefly Clausius Inequality

$\oint dQ\ T \leq 0$ is known as Inequality of Clausius. If 1. $\oint dQ\ T = 0$ the cycle is reversible. 2. $\oint dQ\ T < 0$, the cycle is irreversible and possible . 3. $\oint dQ\ T > 0$, the cycle is impossible (Violation of second law).

3. What are the important characteristics of entropy?

1.If the heat is supplied to the system then the entropy will increase.
2. If the heat is rejected to the system then the entropy will decrease.
3. The entropy is constant for all adiabatic frictionless process.
4. The entropy increases if temperature of heat is lowered without work being done as in throttlingprocess.
5. If the entropy is maximum, then there is a minimum availability for conversion in to work.
6. If the entropy is minimum then there is a maximum availability for conversion into work.

4. What are the Corollaries of Carnot theorem? (May/June 2014)

(i) In the entire reversible engine operating between the two given thermal reservoirs with fixedtemperature, have the same efficiency.
(ii) The efficiency of any reversible heat engine operating between two reservoirs is independent of thenature of the working fluid and depends only on the temperature of the reservoirs.

5. What are the causes of irreversibility? (Nov/Dec 2015)

Four of the most common causes of irreversibility are friction, unrestrained expansion of a fluid, heat transfer through a finite temperature difference, and mixing of two different substances.

6. Define second law efficiency. [Nov/Dec-15]

Second law efficiency is defined as the ratio of change in the available energy of the system and change in the available energy of the source.

7. Define irreversibility? [Nov/Dec-15/R-2008], [May/ June 2016/ R2013]

It is defined as the actual work done by a system is always less than the idealized reversible work, and the difference between the two is called irreversibility. Irreversibility (I) = $W_{MAX} - W = W_{REV} - W$

8. Define Exergy

In impulse turbine, the steam completely expands in the nozzle and its pressure remains constant during its flow through the rotor blades. In reaction turbine, the steam expands partially in the nozzle and remaining in rotor blades.

9. Give Expression of Availability for open system

$$\Phi_{flowing} = (H_1 - H_0) - T_0 (S_1 - S_0) + (KE)_1 - (KE)_0 + (PE)_1 - (PE)_2$$

10. Give Expression of Availability for Closed system

$$\Phi_1 - \phi_2 = (E_1 - E_2) + P_0 (V_1 - V_2) - T_0(S_1 - S_2)$$

11. Differentiate between AE and UAE.

The Available Energy (AE) is also known as exergy and Unavailable Energy (UAE) as energy. The energy which cannot be utilised for doing useful work is called unavailable energy. Irreversibility is equivalent to energy destroyed

12. define dead state in thermodynamics

If the system reaches a state which is in equilibrium with its surroundings, then the system can not exchanges work, heat, and mass with its surroundings. This state is called a dead state and its properties are denoted by subscript 0, such as pressure P_0 and temperature T_0.

UNIT IV

1. What do you understand by pure substance? (Nov/Dec 2013)

A pure substance is defined as one that is homogeneous and invariable in chemical compositionthroughout its mass.

2. Is iced water a pure substance? Why?(Nov/Dec 2016)

If cogeneration systems use renewable options like biogas as their primary fuels, they are an environmentally friendly option for energy production. On the other side however, if a system is using diesel or other fossil fuels as their fuel source than they are not an eco-friendly choice.

3. Define latent heat of evaporation or Enthalpy of evaporation.

The amount of heat added during heating of water up to dry steam from boiling point is known asLatent heat of evaporation or enthalpy of evaporation.

4. Explain the term super-heated steam and super heating.

The dry steam is further heated its temperature raises, this process is called as superheating and thesteam obtained is known as superheated steam

5. Explain the term critical point, critical temperature and critical pressure.

In the T-S diagram the region left of the waterline, the water exists as liquid. In right of the dry steamline, the water exists as a super-heated steam. In between water and dry steam line the water exists as awet steam. At a particular point, the water is directly converted into dry steam without formation ofwet steam. The point is called critical point. The critical temperature is the temperature above which asubstance cannot exist as a liquid; the critical temperature of water is 374.15oC. The correspondingpressure is called critical pressure.

6. Define dryness fraction (or) what is the quality of steam?

It is defined as the ratio of mass of the dry steam to the mass of the total steam

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7. Define enthalpy of steam

It is the sum of heat added to water from freezing point to saturation temperature and the heat absorbed during evaporation

8. Define triple point.

The triple point is merely the point of intersection of sublimation and vaporization curves.

9. Define heat of vaporization

The amount of heat required to convert the liquid water completely into vapour under this condition iscalled the heat of vaporization.

10. Explain the terms, Degree of super heat, degree of sub-cooling

The difference between the temperature of the superheated vapour and the saturation temperature atthe same pressure. The temperature between the saturation temperature and the temperature in the subcooled region of liquid.

11. State the advantages of using superheated steam in turbines. (Nov/Dec 2014)

Superheated steam is a steam at a temperature higher than its vaporization (boiling) point at the absolute pressure where the temperature is measured. The steam can therefore cool (lose internal energy) by some amount, resulting in a lowering of its temperature without changing state (i.e., condensing) from a gas, to a mixture of saturated vapor and liquid.

12. Mention the improvements made to increase the ideal efficiency of Rankine cycle. (Nov/Dec 2014)

1. Lowering the condenser pressure.
2. Superheated steam is supplied to the turbine.
3. Increasing the boiler pressure to certain limit.
4. Implementing reheat and regeneration in the cycle.

UNIT V

1. What are the properties of ideal gas? (Nov/Dec 2014)

1 An ideal gas consists of a large number of identical molecules.

2. The volume occupied by the molecules themselves is negligible compared to the volume occupied by the gas.

3. The molecules obey Newton's laws of motion, and they move in random motion.

4. The molecules experience forces only during collisions; any collisions are completely elastic, and take a negligible amount of time

2. What is equation of state? (Nov/Dec 2012)

The relation between the independent properties such as pressure, specific volume and temperature fora pure substance is known as the equation of state

3. State the Vander Waal's equation of state. (Nov/Dec 2014)

The van der Waals equation (or van der Waals equation of state) is an equation relating the density of gases and liquids (fluids) to the pressure (p), volume (V), and temperature (T) conditions (i.e., it is a thermodynamic equation of state).

4. Explain the construction and give the use of generalized compressibility chart.

The general compressibility chart is plotted with Z versus Pr for various values of Tr. This isconstructed by plotting the known data of one of mole gases and can be used for any gas. This chartgives best results for the regions well removed from the critical state for all gases.

5. What do you mean by reduced properties? (Nov/Dec 2016)

The ratios of pressure, temperature and specific volume of a real gas to the corresponding criticalvalues are called the reduced properties.

6. Explain Dalton's law of partial pressure.

The pressure of a mixture of gases is equal to the sum of the partial pressures of the constituents. The partial pressure of each constituent is that pressure which the gas would expect if it occupied alone thatvolume occupied by the mixtures at the same temperatures. m = mA+mB+mC+..... = mi mi = mass of the constituent. $P=P_A+P_B+P_C+..... = P_i$, P_i – the partial pressure of a constituent.

7. What is compressibility factor?

The gas equation for an ideal gas is given by (PV/RT) = 1, for real gas (PV/RT) is not equal to 1 (PV/RT) = Z for real gas is called the compressibility factor.

8. How does the Vander Waal's equation differ from the ideal gas equation of state?

The ideal gas equation pV=mRT has two important assumptions,

1. There is little or no attraction between the molecules of the gas.
2. That the volume occupied by the molecules themselves is negligibly small compared to the volumeof the gas. This equation holds good for low pressure and high temperature ranges as the Intermolecular attraction and the volume of the molecules are not of much significance. As the pressure increases, the inter molecular forces of attraction and repulsion increases and the volume of the molecules are not negligible. The real gas deviates considerably from the ideal gas equation [p+(a/V2)](V-b) = RT

9. Explain Joule-Kelvin effect. What is inversion temperature?(April/May 2015)

When a gas (not ideal gas) is throttled, the temperature increases up to a point and then decreases. Thisis known as Joule Kelvin effect. The temperature at which the slope of a throttling curve in T-pdiagram is zero is inversion temperature.

10. What is the law of corresponding states? (April/May 2015)

According to Vander Waals, the theorem of corresponding states (or principle of corresponding states) indicates that all fluids, when compared at the same reduced temperature and reduced pressure, have approximately the same compressibility factor and all deviate from ideal gas behaviour to about the same degree.

11. State Helmholtz function.

Helmholtz function is property of system and it is given by subtracting the product of absolute temperature (T) and entropy (s) from the internal energy u. i.e. Helmholtz function = u-Ts

12. State Gibbs Function.

Gibbs function is property of system and is given by G = u – Ts + pv = h – Ts {since h=u+pv} Where h = enthalpy T = Temperature S = Entropy