1. Write the formula of thermal efficiency for Carnot cycle, Otto cycle, Diesel cycle, Stirling cycle and Ericsson cycle.

Carnot cycle:

$$\eta = \frac{|Q_1 - Q_2|}{|Q_1|} = 1 - \frac{|Q_2|}{|Q_1|} = \frac{T_1 - T_2}{T_1} = 1 - \frac{T_2}{T_1}$$

Otto cycle:

$$\eta = 1 - \frac{1}{r^{(\gamma-1)}}$$

γ: the specific heat ratio
r: the compression ratio

Diesel cycle:

$$\eta = 1 - \frac{1}{r^{(\gamma-1)}} \left(\frac{\alpha^\gamma - 1}{\gamma(\alpha - 1)} \right)$$

α: cut-off ratio (ratio between the end and start volume for the combustion phase)

Stirling cycle:

$$\eta = \frac{W}{Q_1} = 1 - \frac{T_2}{T_1}$$

W: net work output
Q_1: heat input

Ericsson cycle:

$$\eta_{th,stirling} = \eta_{th,ericsson} = \eta_{carnot} = 1 - \frac{T_2}{T_1}$$

2. What the difference between Otto cycle and Diesel cycle?

The Diesel cycle is a combustion process of a reciprocating internal combustion engine. In it, fuel is ignited by heat generated during the compression of air in the combustion chamber, into which fuel is then injected. This is in contrast to igniting the fuel-air mixture with a spark plug as in the Otto cycle (four-stroke/petrol) engine.
The Diesel cycle is assumed to have constant pressure during the initial part of the combustion phase. This is an idealized mathematical model: real physical diesels do have an increase in pressure during this period, but it is less pronounced than in the Otto cycle. In contrast, the idealized Otto cycle of a gasoline engine approximates a constant volume process during that phase.
https://en.wikipedia.org/wiki/Diesel_cycle

3. What is regenerator?

A regenerative heat exchanger, or more commonly a regenerator, is a type of heat exchanger where heat from the hot fluid is intermittently stored in a thermal storage medium before it is transferred to the cold fluid. To accomplish this the hot fluid is brought into contact with the heat storage medium, then the fluid is displaced with the cold fluid, which absorbs the heat.
https://en.wikipedia.org/wiki/Regenerative_heat_exchanger

4. What is throttling process? Write the energy balance equation in a throttling process.

In thermodynamics, the Joule–Thomson effect (also known as the Joule–Kelvin effect or Kelvin–Joule effect) describes the temperature change of a real gas or liquid (as differentiated from an ideal gas) when it is forced through a valve or porous plug while keeping it insulated so that no heat is exchanged with the environment. This procedure is called a throttling process or Joule–Thomson process.

$$U_2 - U_1 = p_1 V_1 - p_2 V_2$$
$$i.e. \quad H_1 = H_2$$

https://en.wikipedia.org/wiki/Joule%E2%80%93Thomson_effect

5. What is the difference between vapor cycle and gas cycle?

Gas cycle refers to the thermodynamic cycle in which the working substance is gas.
Vapor cycle refers to the thermodynamic cycle in which the working substance is vapor.

6. Explain the Brayton cycle.

The Brayton cycle is a thermodynamic cycle that describes the operation of certain heat engines that have air or some other gas as their working fluid. The original Brayton Ready Motor used a piston compressor and piston expander, but modern gas turbine engines and airbreathing jet engines also follow the Brayton cycle. Although the cycle is usually run as an open system (and indeed must be run as such if internal combustion is used), it is conventionally assumed for the purposes of thermodynamic analysis that the exhaust gases are reused in the intake, enabling analysis as a closed system.

https://en.wikipedia.org/wiki/Brayton_cycle

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