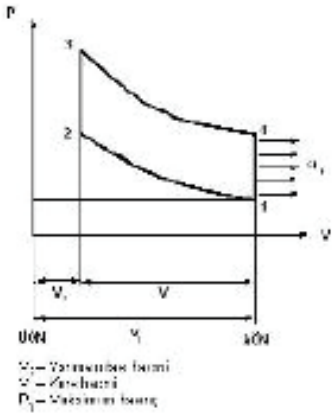
Question 1: An Otto operated4 stroke internal combustion engines pressure at the beginning of expansion is $50x10^5$Pa, temperature at the end of the heat input is 1217^{o}C . The pressure at the beginning of compression is $1,01x10^5$Pa and temperature at this point is 298K. The thermal efficiency is 0,6. Find the mean indicated pressure of this cycle.

$$\eta_{th} = 0,60$$
$$T_3 = 1490K$$
$$P_3 = 50,5x10^5 Pa$$
$$T_1 = 298K$$
$$P_1 = 1,01x10^5 Pa$$



$$\eta_{th} = 1 - \frac{1}{\varepsilon^{k-1}} = 0,60$$
$$T_2 = T_1.\varepsilon^{k-1}$$
$$\frac{P_3}{P_2} = \frac{T_3}{T_2} \rightarrow \frac{P_3}{T_3} = \frac{P_2}{T_2} \rightarrow \frac{50,5x10^5}{1490} = \frac{P_2}{298x\varepsilon^{k-1}}$$
$$P_2 = 10,1x10^5 x\varepsilon^{k-1}$$
$$P_1V_1^k = P_2V_2^k \rightarrow P_1.\varepsilon^k = P_2 \rightarrow \varepsilon = 10$$

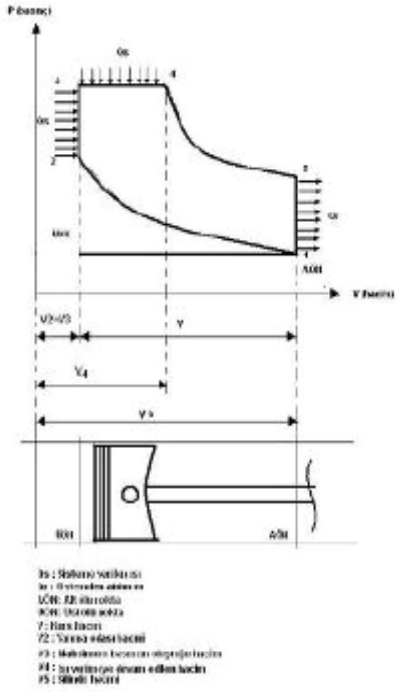
$$\frac{1}{\varepsilon^{k-1}} = 0,4 \rightarrow 10^{k-1} = 2,5 \rightarrow k \cong 1,39$$

$$P_2 = 10,1x10^5 x10^{0,39} = 24,8x10^5 Pa$$
$$\rho = \frac{P_3}{P_2} = 2,03$$

$$P_{mi} = \eta_{th}.\frac{P_1}{k-1}.\frac{\varepsilon^k}{\varepsilon-1}.(\rho-1) = 4,36x10^5 Pa$$
$$N_i = \frac{P_{mi}.\Sigma V_H.n}{60.a} = \frac{4,36x10^5 x1,6x10^{-3} x6000}{60x2}$$
$$= 34800W = 34,8kW$$

Question 2: A Seliniger operated 4 stroke internal combustion engines temperature at the beginning of compression is 50°C and pressure is 0,85bar at this point. The temperature at the end of the compression is 700°C and 41bar at this point. The tmperature is 2646°C and pressure is 61,5bar at the end of the heat input process. Find the thermal efficiency and mean indicated pressure of this cycle.

$$T_1 = 323K$$
$$P_1 = 0,85x10^5 Pa$$
$$T_2 = 973K$$
$$P_2 = 41x10^5 Pa$$
$$T_4 = 2919K$$
$$P_4 = 61,5x10^5 Pa$$



$$\frac{P_1V_1}{P_2V_2} = \frac{mRT_1}{mRT_2} \rightarrow \frac{0,85}{41}\varepsilon = \frac{323}{973} \rightarrow \varepsilon = 16,6$$

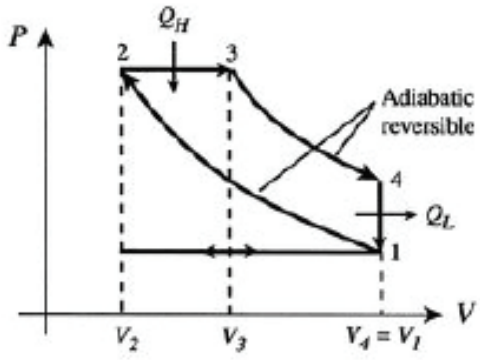
$$T_2 = T_1.\varepsilon^{k-1} \rightarrow \frac{T_2}{T_1} = 3,01 = 16,6^{k-1} \rightarrow k = 1,39$$

$$P_3 = P_4$$
$$\rho = \frac{P_3}{P_2} = \frac{T_3}{T_2} = \frac{61,5}{41} = 1,5$$
$$\rho = \frac{T_4}{\varepsilon_g T_2} \rightarrow \frac{T_4}{T_2} = \rho.\varepsilon_g = \frac{2919}{973} = 3 \rightarrow \varepsilon_g = 2$$

$$\eta_{th} = 1 - \frac{1}{\varepsilon^{k-1}}.\frac{\rho.\varepsilon_g^k - 1}{\rho - 1 + k.\rho.(\varepsilon_g - 1)} = 0,62$$
$$Pmi = \eta_T.\frac{P_1.\varepsilon^k}{(k-1).(\varepsilon-1)}\left[\rho - 1 + k\rho(\varepsilon_g - 1)\right] = 11,11x10^5 Pa$$

Question 3: A Diesel operated 4 stroke internal combustion engines temperature at the beginning of compression is 60°C and pressure is $0,9x10^5$Pa at this point. Temperature at the end of the compression is 680°C, temperature at the end of the expansion is 990K. The adiabatic exponential coefficient is 1,4. Find the temperature and pressure of characteristic points and find the indicated mean effective pressure of cycle.

$$P_1 = 0,9x10^5\,Pa$$
$$T_1 = 333K$$
$$T_2 = 953K$$
$$T_4 = 990K$$
$$k = 1,4$$



$$P_4 = \frac{P_1.T_4}{T_1} = 2,67x10^5\,Pa$$
$$T_2 = T_1.\varepsilon^{k-1} \rightarrow 953 = 333\varepsilon^{0,4} \rightarrow \varepsilon = 13,84$$
$$P_1V_1^k = P_2V_2^k \rightarrow P_1.\varepsilon^k = P_2 = 0,9x10^5\,x13,84^{1,4}$$
$$= 35,63x10^5\,Pa$$
$$P_2 = P_3$$

$$\frac{P_4}{P_1} = \varepsilon_g^k \rightarrow \varepsilon_g^{1,4} = 2,966 \rightarrow \varepsilon_g = 2,174$$
$$T_3 = T_2.\varepsilon_g = 953x2,174 = 2071K$$

$$\eta_{th} = 1 - \frac{1}{\varepsilon^{k-1}}.\frac{\varepsilon_g^k - 1}{k.(\varepsilon_g - 1)} = 0,58$$
$$Pmi = \eta_T.\frac{P_1.\varepsilon^k.k.(\varepsilon_g - 1)}{(k-1).(\varepsilon - 1)} = 6,613x10^5\,Pa$$

Question 4: A Diesel operated 4 stroke internal combustion engines stroke is 98mm The temperature at the before 60mm from top dead centre during he compression process is 100ºC and pressure is 1.5bar at this point Temperature at the before 60mm from top dead centre during expansion process is 933ºC. Pre-expansion ratio is given as 2,3 and temperature at the end of the compression stroke is 688ºC. Find the characteristic points temperature and pressure value of this cycle.