Q1. Below listed parameters are given for a four stroke engine operated according to air standard Otto cycle. Please calculate the pressure and temperature of the characteristic points, thermal efficiency, mean indicated pressure and the indicated power of the engine.

-Start of compression pressure is one Bar

-Start of compression temperature is 25 ° C

-Compression ratio is 11

-Pressure increase ratio is 2

-Single cylinder capacity of this four-cylinder engine is 400cc

-Total capacity of the engine 4*400cc=1600cc

-Ratio of specific heats 1.41

-Engine speed 6000 rpm

P_1= 1 Bar, $P_2 = P_1 . \varepsilon^k$ => $P_2 = 1 \times (11)^{1,41}$ => P_2 = 29,4 Bar

$\frac{P_3}{P_2} = \rho$ => $P_3 = (29,4) \times 2$ => P_3 = 58,8 Bar

$P_4 . \varepsilon^k = P_3$ => $P_4 = \frac{58,8}{11^{1,41}}$ => P_4 = 2 Bar

T_1 = 298° K, $T_2 = T_1 . \varepsilon^{k-1}$ => $T_2 = 298 \times (11)^{(1,41-1)}$ => T_2 = 796,5° K

$\frac{T_3}{T_2} = \rho$ => $T_3 = (796,5) \times 2$ => T_3 = 1593° K

$T_4 . \varepsilon^{k-1} = T_3$ => $T_4 = \frac{1593}{11^{(1,41-1)}}$ => T_4 = 596° K

$\eta_t = 1 - \frac{1}{\varepsilon^{k-1}}$ => $\eta_t = 1 - \frac{1}{11^{(1,41-1)}}$ => η_t = 0,6259

$P_{mi} = \eta t . \frac{P_1}{k-1} . \frac{\varepsilon^k}{\varepsilon - 1} . (\rho - 1)$ => $P_{mi} = (0,6259)\ x\ \frac{1}{(1,41-1)}\ x\ \frac{(11)^{1,41}}{(11-1)}\ x\ (2-1)$

=> P_{mi} = 4,488 Bar = 4,488 x 10^5 Pa

$N_i = \frac{P_{mi}.V_H.z.n}{60.a}$, z = 4, a = 2, n = 6000 rpm, V_H = 400 x 10^{-6} m^3

=> $N_i = \frac{(4{,}488\ x\ 10^5)\ x\ (400\ x\ 10^{-6})\ x\ 4\ x\ 6000}{60\ x\ 2}$

=> N_i = 35,904 kW

Q2. Below listed parameters are given for a four stroke engine operated according to air standard Diesel cycle. Please calculate the pressure and temperature of the characteristic points, thermal efficiency, mean indicated pressure and the indicated power of the engine.

-Start of compression pressure is one Bar

-Start of compression temperature is 25 ° C

-Compression ratio is 14

-Pre-expansion ratio is 2.3

-Single cylinder capacity of this six-cylinder engine is 500cc

-Total capacity of the engine 6*500cc=3000cc

-Ratio of specific heats 1.41

-Engine speed 4000 rpm

P_1= 1 Bar, $P_2 = P_1. \mathcal{E}^k$ => $P_2 = 1 \text{ x } (14)^{1,41}$ => P_2 = 41,3 Bar

$P_3 = P_2$, $P_4 = P_1.\mathcal{E}_g^{\ k}$ => $P_4 = 1 \text{ x } (2{,}3)^{1,41}$ => P_4 = 3,24 Bar

T_1 = 298° K, $T_2 = T_1. \mathcal{E}^{k-1}$ => $T_2 = 298 \text{ x } (14)^{(1,41-1)}$ => T_2 = 879,3° K

$\frac{V_3}{V_2} = \frac{T_3}{T_2} = \mathcal{E}_g$ => T_3 = (879,3) x (2,3) => T_3 = 2022,35° K

$T_4 = T_1. \mathcal{E}_g^{\ k}$ => $T_4 = 298 \text{ x } (2{,}3)^{1,41}$ => T_4 = 964° K

$\eta_t = 1 - \frac{\varepsilon_g{}^{k} - 1}{k.(\varepsilon_g - 1).\varepsilon^{k-1}}$ => $\eta_t = 1 - \frac{(2,3)^{1,41} - 1}{1,41\ x\ (2,3-1)\ x\ (14)^{(1,41-1)}}$

=> $\eta_t = 0,586$

$P_{mi} = \eta_t . \frac{P_1.\varepsilon^{k}.k.(\varepsilon_g - 1)}{(k-1).(\varepsilon-1)}$ => $P_{mi} = (0,586)\ x\ \frac{1\ x\ (14^{1,41})\ x\ (1,41)\ x\ (2,3-1)}{(1,41-1)\ x\ (14-1)}$

=> $P_{mi} = 8,324$ Bar $= 8,324 \times 10^5$ Pa

$N_i = \frac{P_{mi}.V_H.z.n}{60.a}$, z = 6, a = 2, n = 4500 $\frac{d}{d}$, $V_H = 500 \times 10^{-6}\ m^3$

=> $N_i = \frac{(8,322\ x\ 10^5)\ x\ (500\ x\ 10^{-6})\ x\ 6\ x\ 4000}{60\ x\ 2}$

=> $N_i = 83,24$ kW