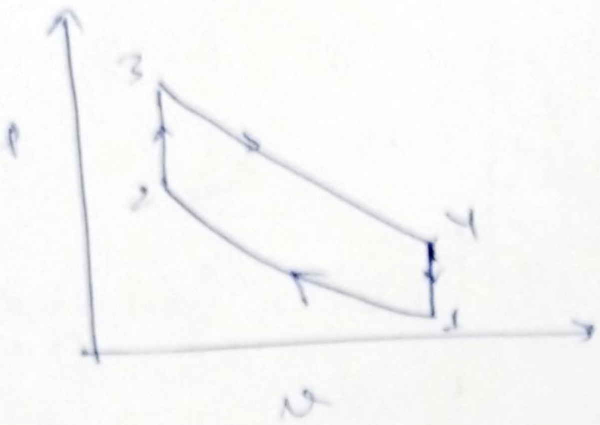
otto cycle

Q5



$P_1 = 1$ bar

$T_1 = 290$ K

$v_1 = 400\ cm^3$

$T_3 = 2200$ K

$\frac{V_1}{V_2} = 8$

find (a) Heat add^n (b) net work done (c) η_{th} (d) P_{mep}

(a) $\dot{Q}_{add} = \dot{Q}_{2-3} = \dot{m} c_v (T_3 - T_2)$

using isentropic rel^n $= \frac{T_1}{T_2} = \left(\frac{v_2}{v_1}\right)^{\gamma-1}$

$\Rightarrow \boxed{T_2 = T_1 \times \left(\frac{v_1}{v_2}\right)^{\gamma-1}}$

$Q_{2-3} = m c_v (T_3 - T_2) = \frac{P_1 V_1}{R T_1} \cdot c_v (T_3 - T_2)$

(b) $W_{net} = Q_{2-3} - Q_{4-1} = m c_v \{(T_3 - T_2) - (T_4 - T_1)\}$

$\frac{T_4}{T_3} = \left(\frac{v_3}{V_4}\right)^{\gamma-1} \Rightarrow \boxed{T_4 = T_3 \left(\frac{v_3}{v_4}\right)^{\gamma-1} = T_3 \left(\frac{v_2}{v_1}\right)^{\gamma-1}}$

(c) $\eta_{th} = \frac{W_{net}}{Q_{2-3}}$

(d) $= P_{mep} \cdot V_{swept} = W_{net} \Rightarrow P_{mep} = \frac{W_{net}}{V_{swept}} = \frac{W_{net}}{V_1 - V_2}$

Q 6

4-stroke - 4 cyl. IC engine

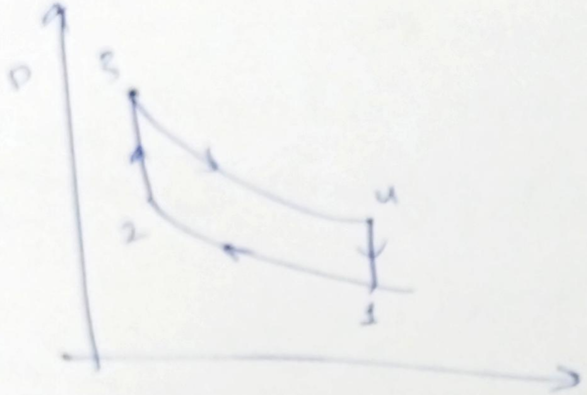
$d = 10\,cm$, $L = 9\,cm$

$N = 2400\,rpm$

$\frac{V_2}{V_1} = 0.16$

otto cycle

$V_1 - V_2 = \frac{\pi D^2}{4} \cdot L$



$P_1 = 1\,bar$

$T_1 = 16^\circ C$

$T_3 = 2616^\circ C$

find W_{net}/cycle

$\boxed{\text{Work per cylinder per cycle} \Rightarrow \dot{W}_{net}} = Q_{2-3} - Q_{4-1}$ → can be found same as previous problem

* As ~~the~~ this is 4-stroke engine so, to generate one power stroke it ~~with~~ will need 2 revolutions of crankshaft

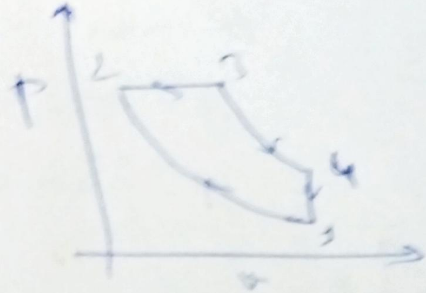
If we want to calculate total work done generated by the engine

$$\boxed{\dot{W}_{tt} = W_{net} \times \underbrace{\frac{1}{2} \times \frac{2400}{60}}_{\text{no. of power stroke/sec}} \times \underbrace{4}_{\text{no. of cyl.}} = \frac{2\pi NT}{60}}$$

* I think in class discussion I did mistake in calculation of Torque. pls ignore that

Total work done per cycle = $\boxed{\frac{W}{cycle} = 4 \times W_{net} = 4(Q_{23} - Q_{41})}$

Q 7 Diesel cycle



$P_1 = 170\,kPa$

$V_1 = 0.016\,m^3$

$T_1 = 315\,K$, $\frac{V_1}{V_2} = 15$

$T_3 = 1400\,K$

$m = \frac{P_1 V_1}{R T_1}$, $Q_{23} = m c_p (T_3 - T_2) \rightarrow T_2$ can be obtained by isentropic relation

$Q_{4-1} = \cancel{m c}\ m c_v (T_4 - T_1)$

T_4 can be obtained same as T_2

$$\boxed{W_{net} = Q_{2-3} - Q_{4\,1}}$$

$$\boxed{\eta_{th} = \frac{W_{net}}{Q_{2-3}}}$$

Q 8

$V_{swept} = 25\,m^3$, $N = 200\,rpm$

2 stroke , $P = 100000\,hp$

$P_1 = 200\,kPa$, $T_1 = 300\,K$

$\frac{V_1}{V_2} = 20:1$

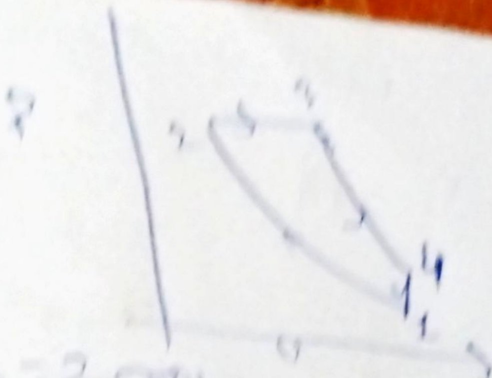
~~Power = P... W/cycle = Pmep × Vswept × 200/60 × 1~~

$W/cycle = P_{mep} \times V_{swept}$

$Power = \frac{W}{cycle} \times \frac{N}{60} \times 1 = P_{mep} \times V_{swept} \times \frac{N}{60}$

$$\Rightarrow \boxed{P_{mep} = \frac{100000 \times 0.746 \times 60}{200 \times 25}\ kPa}$$

13 Diesel cycle



$$\frac{v_1}{v_2} = 16$$

$$\frac{v_3}{v_2} = 2$$

$P_1 = 0.95\ \text{bar}$ $\quad T_{source} = 2000\,K$

$T_1 = 27^\circ C$ $\quad T_{sink} = 300\,K = T_0$

find total Exergy destruction

Total Exergy destruction $= T_0\,\phi$

Entropy balance eqn

$$\underbrace{\frac{dS}{dt}}_{\text{Steady State}}^{=0} = \underbrace{\dot m_i s_i - \dot m_e s_e}_{\text{cyclic process}}^{=0} + \sum \frac{Q}{T} + \phi \Rightarrow \phi = -\left[\sum \frac{Q}{T}\right]$$

$$\Rightarrow \phi = -\left\{ \frac{m c_p (T_3 - T_2)}{2000} - \frac{m c_v (T_4 - T_1)}{300} \right\}$$

$$\text{Exergy dest} = T_0 \times \phi = -300\left[\frac{m c_p (T_3 - T_2)}{2000} - \frac{m c_v (T_4 - T_1)}{300}\right]$$

Exergy at pt. 2

$$\psi_2 - \psi_0 = m\left[(u_2 - u_0) + P_0 (v_2 - v_0) - T_0 (s_2 - s_0)\right]$$