

Powertrain and Control

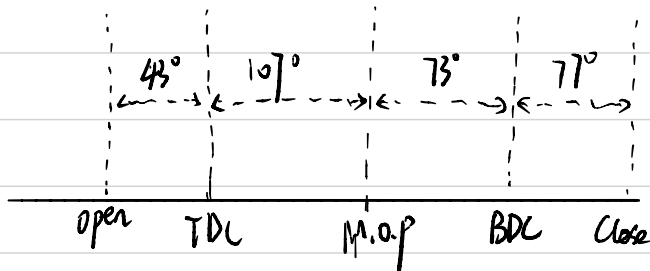
MGX00404

Name: Zhendu Fang

Student Number: 1904716

Question Two

a)



duration = 360°

the angle between M.O.P and midpoint between BDC and closing
 $73^\circ + \frac{77^\circ}{2} = 111.5^\circ$

the intake port length is 60 mm

the time for pulse is $\frac{2\pi(L+0.06)}{330}$

the time for crank to turn 111.5° at 13800 rpm

$$T = \frac{111.5}{360} \times \frac{60}{13800}$$

So we get

$$\frac{111.5}{360} \times \frac{60}{13800} = \frac{2\pi(L+0.06)}{330}$$

$$L + 0.06 = \frac{0.444}{2\pi}$$

$$n=1 \quad L = 0.162 \text{ m}$$

$$n=2 \quad L = 0.051 \text{ m}$$

for trump length, 0.162 m is more practical

b) similar with (a)

time for rank at 10800 rpm

$$T = \frac{11.5}{360} \times \frac{60}{10800}$$

So we get

$$\frac{11.5}{360} \times \frac{60}{10800} = \frac{2\pi(L+0.06)}{330}$$

$$L+0.06 = \frac{0.568}{2\pi}$$

$$n=1 \quad L = 0.224 \text{ m}$$

$$n=2 \quad L = 0.082 \text{ m}$$

0.224 m is more practical

if $n=1$ the length difference is 62 mm, it is acceptable to package these two lengths.

if $n=2$ the length difference is 31 mm, it is less than the situation $n=1$, but the overall length is quite short.

c) repeat the following equation

$$\frac{2n(L+0.06)}{360} = \frac{111.5}{360} \cdot \frac{60}{\text{RPM}}$$

we get

	0.162 m	0.224 m
1	13812	10797
2	6906	5398
3	4604	3599
4	3453	2699
5	2762	2159

considering the more need on power, 0.162 m provides most useful harmonic spread.

d) ① the pressure pulse in exhaust pipe begins around 20° after the valve opening

② due to the high temperature of exhaust air, the speed of pulse wave is faster, determined by equation $v = v_0 \sqrt{\frac{T}{T_0}}$

③ there are more options to assemble the four exhaust pipes.

Question 3.

a) the float occurs when contact force is zero. At this moment, the valve has full lift ($x = 10.66 \text{ mm}$)

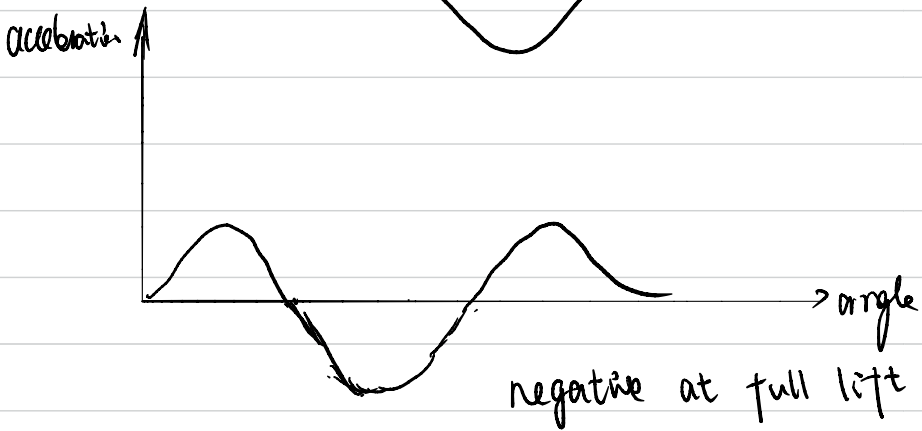
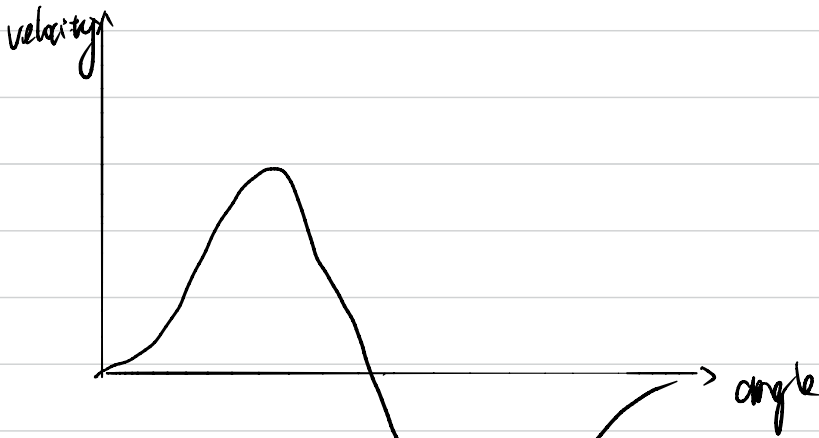
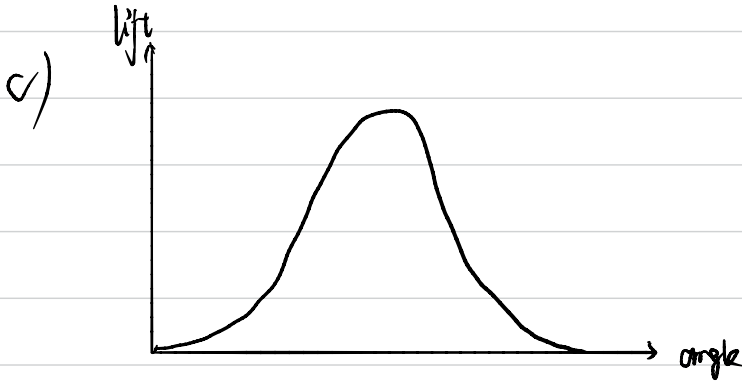
according to the moving equation of valve

$$F_c - k(x_0 + x) = ma$$

$$0 - 18800(0.004 + 0.01066) = 0.172 \times a$$

$$a = -1602.4 \text{ m/s}^2$$

b)	Angle	Lift	velocity	Acceleration
	110	10.651		
	111	10.654	0.003	
	112	10.658	0.004	0.001
	113	10.660	0.002	-0.002
	114	10.658	-0.002	-0.004
	115	10.654	-0.004	-0.002
	116	10.651	-0.003	-0.001



d) max acceleration is -0.004 mm/s^2

$$\begin{aligned}\text{valve acceleration} &= \frac{-0.004}{1000} \times (6 \times 3100)^2 \\ &= 1383.84 \text{ m/s}^2\end{aligned}$$

This is 86.3% of ~~max~~ acceleration that occurring

e) float occurs at -1602.4 m/s^2
Then

$$-1602.4 = \frac{-0.004}{1000} \times (6 \times \text{RPM})^2$$

$$(6 \times \text{RPM})^2 = 4.006 \times 10^8$$

$$\text{RPM} = \sqrt{\frac{4.006 \times 10^8}{36}}$$

$$\text{RPM} = 3336$$

This is cam RPM

the crank RPM is 6672 rpm

safe limit of 6600 rpm will be fine

Question Four.

[I am not sure 875 cc is the displacement volume of one cylinder or two. I calculate as one.
If it is total volume, the all calculations concerning volume should be divided by 2]

$$a) \quad \frac{T_2}{T_1} = \left(\frac{V_1}{V_2} \right)^{\gamma-1}$$

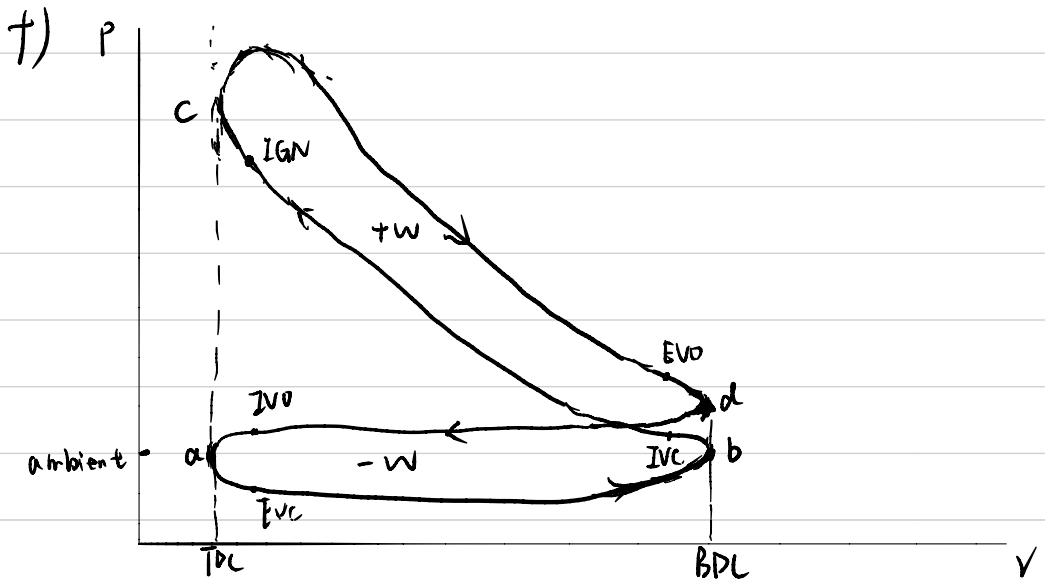
$$T_2 = T_1 \cdot \left(\frac{V_1}{V_2} \right)^{\gamma-1} = (32 + 273) \cdot 10^{1.35-1} \\ = 682.8 \text{ K}$$

$$b) \quad \text{air mass trapped} = 0.9 \times 875 \times 10^{-6} \times 3.52 = 2.772 \times 10^{-3} \text{ kg} \\ \text{fuel mass trapped} = 2.772 \times 10^{-3} \div 14.7 = 1.886 \times 10^{-4} \text{ kg} \\ \text{heat output} = 1.886 \times 10^{-4} \times 44 \times 10^6 \times 0.9 = 7468.56 \text{ J} \\ \Delta T = \frac{Q}{mc_v} = \frac{7468.56}{(2.772 \times 10^{-3} + 1.886 \times 10^{-4}) \times 1000} = 2505.1 \text{ K}$$

$$c) \quad T_4 = T_3 \left(\frac{V_3}{V_4} \right)^{\gamma-1} = (682.8 + 2505.1) \times 0.1^{2.31} \\ = 1561.4 \text{ K}$$

$$d) \quad P_2 = P_1 \cdot \left(\frac{V_1}{V_2} \right)^{\gamma} = 2 \times 10^{1.35} = 44.8 \text{ bar} \\ P_3 = P_2 T_3 \cdot T_2^{-1} = \frac{44.8 \times (682.8 + 2505.1)}{682.8} = 209 \text{ bar}$$

$$e) \quad Q = mc_v \Delta T = (2.772 \times 10^{-3} + 1.886 \times 10^{-4}) \times 1000 \times (1561.4 - 305) \\ = 3745.7 \text{ J}$$



a-b : inlet

b-c : compression $PV^{\gamma} = c$

c-d : expansion $PV^{\gamma} = c$

d-a : exhaust