

DATE : 12/05/2020
 TIME : 1pm
 MODULE TITLE: Powertrain and control
 MODULE CODE: MSX00707
 NAME: Alexander Baldwin
 STUDENT NUMBER: 1801714

a) ~~wiebe~~ f

$$MFB = 1 - e^{-a \left(\frac{\theta - \theta_0}{\Delta\theta} \right)^{n+1}}$$

where $a = \text{constant}$

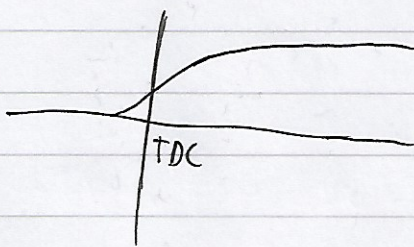
$n = \text{constant}$

$\theta = \text{crank angle}$

$\theta_0 = \text{start of combustion}$

$\Delta\theta = \text{Burn duration}$

b)



The wiebe function is used to predict burn ~~rate~~ fractions and burn ~~rates~~ rates in internal combustion engines

c)

a. This process represents the polytropic process

b. 'n' is the polytropic index

~~c. it represents the change in what state the thermodynamic~~

c. It represents what thermodynamic state ~~the~~ ^{an} internal combustion engine is in

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d. n remains ~~lighty~~ constant between 0 and 1

e. Between 0 and 1

d)

a. Because hybrids still run on internal combustion engines unless ~~in~~ going at slow speeds when stuck in traffic. Also ~~not~~ people who drive hybrids do not know how to control them efficiently, sometimes making them less fuel efficient

b. Electric cars will only be a good solution if the ~~countries~~ ^{UK} finds a more sustainable ~~way~~ ^{way} of producing electricity and a safer way to dispose of lithium batteries. ~~Cars are also as~~ ^{As of now, I believe} all electric cars are not a ~~very~~ ^{very} viable solution.

c. As hydrogen is basically everywhere, it is extracted and some ~~gas~~ ^{gas} will never run out. It is packaged in very high pressure tanks which can potentially be dangerous.

d. Biofuels are a lot less polluting than fossil fuels and they are ~~renewable~~ ^{renewable}. The cons are that a lot of land is used to create the fuel

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and engines need to be ~~converted~~ modified to use biofuels

- e. Synthetic fuels are a mixture of petrol or diesel or kerosene with hydrogen. They come from many sources, ~~like~~ for example coal, biomass or natural gas.

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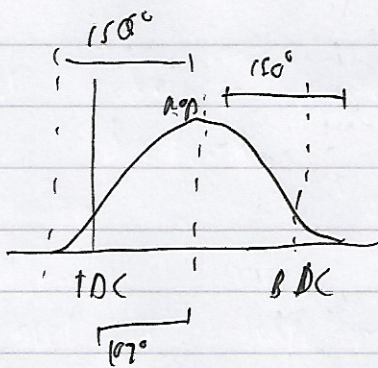
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2a)



~~$$(10 \times 10^3) - 14.475 \times 10^3$$~~

$$13000 \text{ rpm}$$

~~$$\text{Average} = \frac{(10 \times 10^3) + 14.475 \times 10^3}{2}$$~~

~~$$= 12237.5 \text{ rpm}$$~~

$$60 \text{ mm}$$

~~$$= 12.2375 \times 10^3 \text{ rpm}$$~~

$$= 0.06 \text{ mm}$$

$$150 - 107 = 43^\circ$$

$$\text{between } Mop \text{ and } BDC = \frac{43 + 150}{2} = 111.5^\circ$$

$$\text{time for 1 pulse} = \frac{2\pi(1 + 0.06)}{330}$$

$$\text{time for 1 crank} = \frac{107}{360} \cdot \frac{60}{13000}$$

$$\therefore \frac{107}{360} \cdot \frac{60}{13000} = \frac{2\pi(1 + 0.06)}{330}$$

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$$\left(\frac{107}{360} \cdot \frac{60}{13000} \right) 330 = 2\pi(L + 0.06)$$

$$L + 0.06 = \frac{330}{2\pi} \cdot \frac{107}{360} \cdot \frac{60}{13000}$$

$$L = \left(\frac{330}{2\pi} \cdot \frac{107}{360} \cdot \frac{60}{13000} \right) - 0.06$$

$$\cancel{A_1} \quad L = \left(\frac{330}{2(1)} \cdot \frac{107}{360} \cdot \frac{60}{13000} \right) - 0.06$$

$$\cancel{L = 0.14m} \quad L = 0.153m$$

$$\cancel{A_2} \quad \cancel{L = 0.042m} \quad L = 0.047m$$

$$\boxed{\cancel{L = 0.14m}}$$

$$\boxed{L = 0.153m}$$

b) 10800 rpm

$$L = \left(\frac{330}{2\pi} \cdot \frac{107}{360} \cdot \frac{60}{10800} \right) - 0.06$$

$$A_1 = L = \left(\frac{330}{2(1)} \cdot \frac{107}{360} \cdot \frac{60}{10800} \right) - 0.06$$

$$L = 0.212m$$

$$A_2 \quad L = 0.0762m$$

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n_1 seems too large so does not seem viable therefore n_2 is the viable

$$L = 0.0762 \text{ m}$$

so between 0.0762m and 0.07m

$$c) \text{ RPM} = \frac{107}{360} \cdot \frac{60 \cdot 330}{2\pi(L+0.06)}$$

so for 14775 rpm

$$n=2 \quad L = 0.0416 \text{ m}$$

between 0.0416m and 0.0762m

$$c) \text{ RPM} = \frac{107}{360} \cdot \frac{60 \cdot 330}{2\pi(L+0.06)}$$

~~n=1~~	0.0416m	0.0762m
~~n=1~~	~~28961~~	<del></del>
n=2	14480 rpm	10802 rpm
n=3	9654 rpm	7201 rpm
n=4	7240 rpm	5401 rpm
n=5	5792 rpm	4321 rpm

the length of 0.0416m is the best one as it has the better spread.

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d) The lengths are much longer in the exhaust. So add the port length to the intake trumpet length

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3a)



$$F_c = k(x + x_0) + M_0$$

$$F_0 = 0 \quad 0 = 18.8(10.66 + 4) + 0.172g$$

$$\frac{18.8(10.66 + 4)}{0.172} = g$$

$$g = -1602 \text{ ms}^{-2}$$

b)

CAM angle (°)	Valve lift (mm)	Valve velocity (mm/s)	Valve acceleration (mm/s²)
110	10.651		
111	10.659	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

c)

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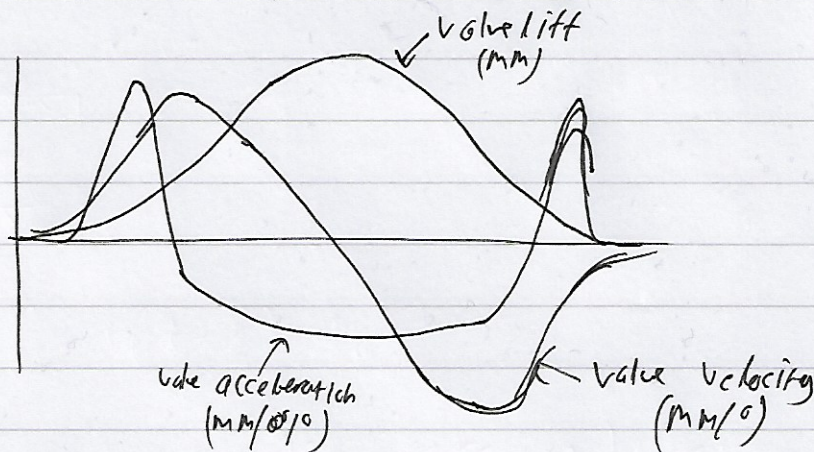
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c)



d)

6200 rpm max acceleration = $-0.004 (\text{mm/s}^2)$

~~$$\text{valve acceleration (ms}^{-2}\text{)} = \frac{-0.004 \cdot (6 \cdot 6200)^2}{1000}$$~~

$$\text{valve acceleration (ms}^{-2}\text{)} = \frac{-0.004 \left(6 \cdot \frac{6200}{2}\right)^2}{1000}$$

$$= \frac{-0.004 (6 \cdot 3100)^2}{1000}$$

$$= 1383.84 \text{ ms}^{-2}$$

valve float occurs at 3300 ms⁻²

so 41.93% of max acceleration before float

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e) Given float of -3300 ms^{-2}

$$\cancel{1000(-3300)} = \cancel{-0.004(6 \cdot \text{CAM RPM})^2}$$

$$1000(-3300) = -0.004(6 \cdot \text{RPM}_{\text{CAM}})^2$$

$$\frac{1000(-3300)}{-0.004} = (6 \cdot \text{RPM}_{\text{CAM}})^2$$

$$\sqrt{\frac{1000(-3300)}{-0.004}} = 6 \cdot \text{RPM}_{\text{CAM}}$$

$$\text{RPM}_{\text{CAM}} = \frac{\sqrt{\frac{1000(-3300)}{-0.004}}}{6}$$

$$\text{RPM}_{\text{CAM}} = \frac{\sqrt{825 \times 10^6}}{6}$$

$$\begin{aligned} \text{RPM}_{\text{CAM}} &= 4787.14 \text{ rpm} \\ &= 4787 \text{ rpm} \end{aligned}$$

the crank rpm that float will occur is
 $4787 \times 2 = 9574 \text{ rpm}$

The safety limit in high performance is at 15%
 so a crank rpm of 9574 is a safe ~~red~~ line
 for rev limit