

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  $a = \text{constant}$

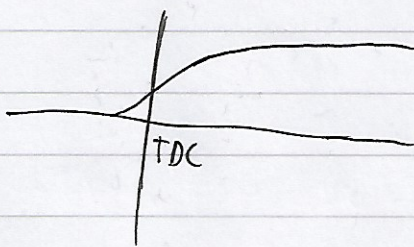
$n = \text{constant}$

$\theta = \text{crank angle}$

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

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

b)



The wiebe function is used to predict burn ~~rate~~ fractions and burn ~~rate~~ 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

DATE: 12/05/2020

TIME: 1pm

MODULE ~~CODE~~ <sup>TITLE:</sup> Powertrain and Control

MODULE CODE: MSX00404

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STUDENT NUMBER: 1801719

d.  $n$  remains ~~lightly~~ constant between 0 and 1

e. Between 0 and 1

d)

a. Because hybrids still run on internal combustion engines unless ~~it's~~ 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~~ <sup>UK</sup> finds a more sustainable ~~way~~ <sup>way</sup> of producing electricity and a safer way to dispose of lithium batteries. ~~Cars are also as~~ <sup>As of now, I believe</sup> all electric cars are not a ~~very~~ <sup>very</sup> viable solution.

c. As hydrogen is basically everywhere, it is extracted and some ~~gas~~ <sup>gas</sup> 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~~ <sup>renewable</sup>. The cons are that a lot of land is used to create the fuel

DATE: 12/05/202

TIME: 1pm

MODULE TITLE: Powertrain and Control

MODULE CODE: MSX00404

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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.

DATE: 12/05/2020

TIME: 1pm

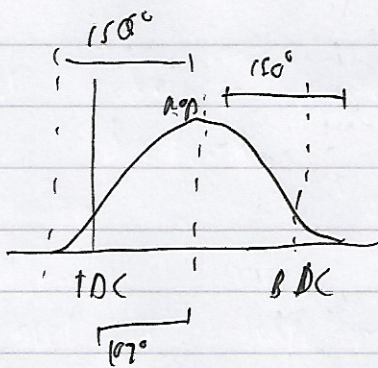
MODULE TITLE: Powertrain and Control

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2a)



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

$$13000 \text{ rpm}$$

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

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

$$60 \text{ mm}$$

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

$$= 0.06 \text{ mm}$$

$$180 - 107 = 73^\circ$$

$$\text{between } Mop \text{ and } BDC = \frac{73 + 150}{2} = 111.5^\circ$$

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

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

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

DATE: 12/05/202

TIME: 1pm

MODULE TITLE: Powertrain and Control

MODULE CODE: MSX00909

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$$\left( \frac{107}{360} \cdot \frac{60}{13800} \right) 330 = 2\pi(L + 0.06)$$

$$L + 0.06 = \frac{330}{2\pi} \cdot \frac{107}{360} \cdot \frac{60}{13800}$$

$$L = \left( \frac{330}{2\pi} \cdot \frac{107}{360} \cdot \frac{60}{13800} \right) - 0.06$$

~~Ans~~  
 $n_1$   $L = \left( \frac{330}{2(1)} \cdot \frac{107}{360} \cdot \frac{60}{13800} \right) - 0.06$

~~$L = 0.14m$~~   $L = 0.153m$

~~Ans~~  
 $n_2$   ~~$L = 0.042m$~~   $L = 0.047m$

~~$L = 0.14m$~~

$L = 0.153m$

b) 10800 rpm

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

$n_1$   $L = \left( \frac{330}{2(1)} \cdot \frac{107}{360} \cdot \frac{60}{10800} \right) - 0.06$

$L = 0.212m$

$n_2$   $L = 0.0762m$

DATE: 12/05/2020

TIME: 1pm

MODULE TITLE: Powertrain and Control

MODULE CODE: MSX 00404

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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

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

| <del>n=1</del> | 0.0416m          | 0.0762m     |
|----------------|------------------|-------------|
| <del>n=1</del> | <del>28961</del> | <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.

DATE: 12/05/2020

TIME: 1 pm

MODULE TITLE: Powertrain and Control

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

DATE: 12/05/2020

TIME: 1pm

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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)

DATE : 12/05/2020

TIME : 1 pm

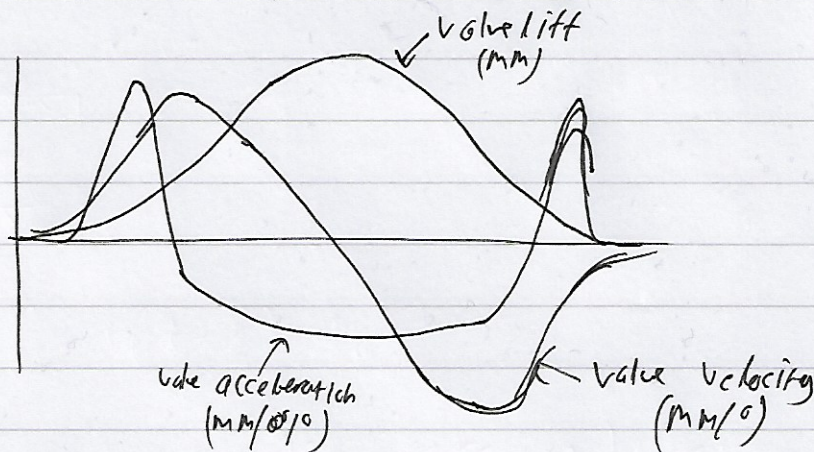
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c)



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<sup>-2</sup>

so 41.93% of max acceleration before float

DATE: 12/05/2020

TIME: 1pm

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

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

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

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

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

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

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

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

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