

Date 12/05/2020

Time: 1:00pm

Module Powertrain and Control, M5200404

Name Geoffrey Ellis

Student Number: 18026414

~~Question 4~~ Question 1

a)

Wiebe Function

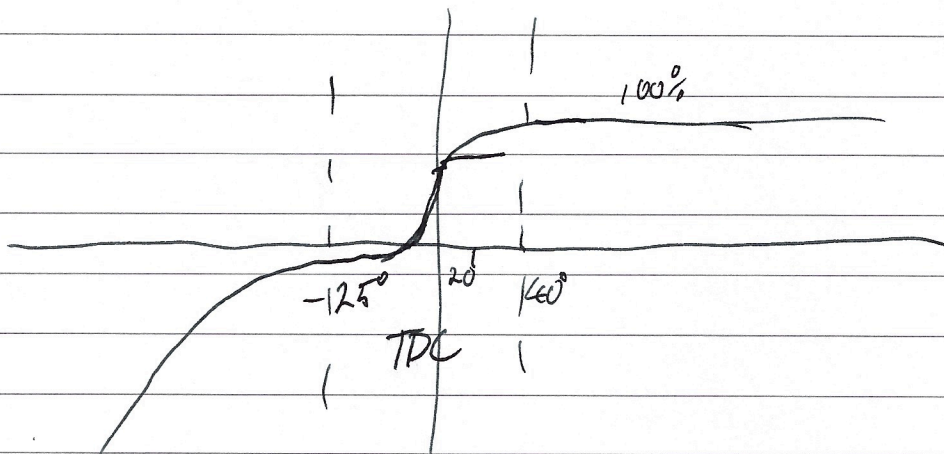
$$MFB = 1 - e^{-a \left(\frac{\theta - \theta_0}{\Delta Q} \right)^{m+1}}$$

notation

MFB = mass fuel burned
 ΔQ = Burn duration
 θ = crank angle
 θ_0 = start of combustion

a and m are constants
 found by curve fitting
 with some trial and
 error.

b)



The highlighted section is used to represent the portion of the fuel which has been burnt at a given crank angle.

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c) $PV^n = \text{constant}$

a) a polytropic process

b) n is the polytropic index, it represents the type of process it is isentropic, isothermal etc.

c) Changing n represents the time that combustion is beginning during compression.

d) n becomes useless during the combustion as phase fluctuating wildly

e) limits for n are 1 to 1.4

d) Manufacturers have created hybrid vehicles which are no more environmentally friendly than most straight petrol vehicles.

b) I do not believe all electric is a viable option in a relatively short time frame. Difficulties in mass charging and charging times need to be dealt with first. I do not think there will be sufficient energy generation capacity to charge two EV's per household per night. Furthermore the infrastructure to deliver high power fast charging points is expensive and uncommon at the moment.

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- c) Hydrogen can be burned much the same as petrol as BMW demonstrated a few years ago. Storage is more difficult but not impossible.
It can also be used to power electric vehicles in fuel cells. One major concern here would be using electrolysis to create hydrogen only to reverse the process expending much energy to create it.

d) Biofuels

^{can be}
Pros - Made from waste products

- Cheap at the moment

Cons - Limited production at the moment

- e) Synthetic fuels can be created using CO_2 from the air and hydrogen. This filters the CO_2 that is already in the air making it a raw material new and making synthetic fuel vehicles carbon neutral.

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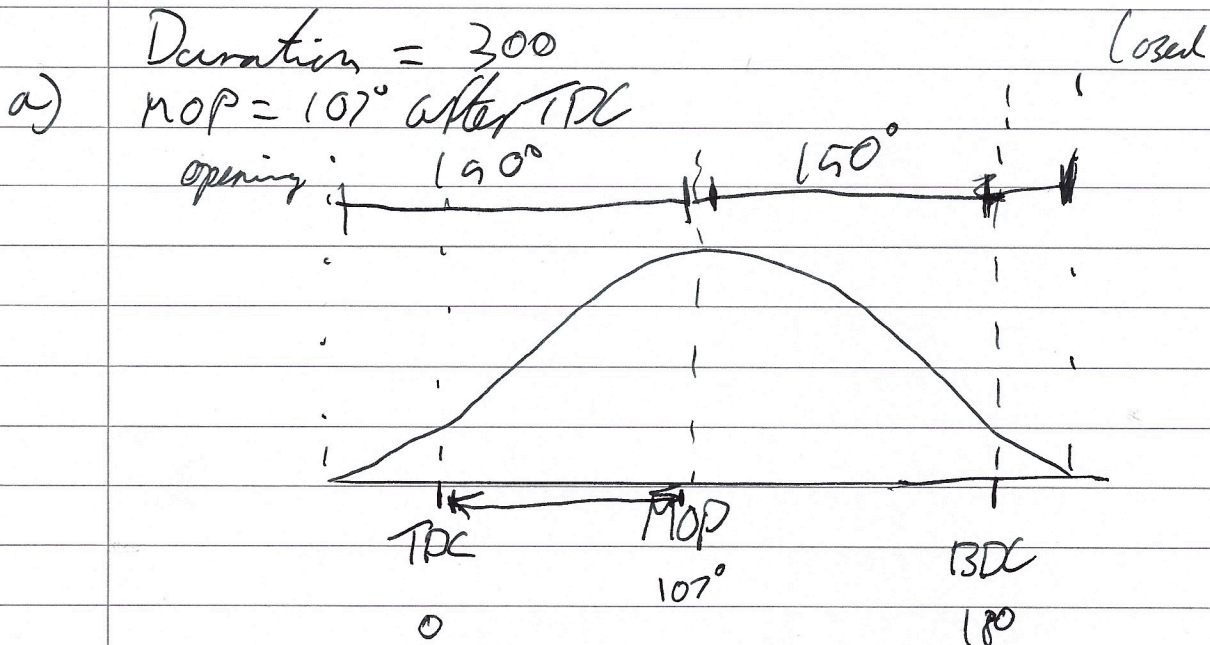
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Module Powertrain and control, M5X00404

Name Seffrey Ellis

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Question 2



Angle between MOP and midpoint of BDC and closing =

$$\frac{((180 - 107) + 150)}{2} = 111.5^\circ$$

$$L_p = 60 \text{ mm} = 0.06 \text{ m}$$

$$SCB = 330 \text{ m/s @ } 20^\circ\text{C}$$

$$RPM = 13200 \text{ rpm}$$

$$\text{Time for crank to turn} = \frac{111.5}{360} \times \frac{60}{13200} =$$

$$\text{Time for 1 pulse} = \frac{2N(L + 0.06)}{330}$$

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For the first harmonic

$$\frac{11.5}{360} \times \frac{60}{13800} = \frac{2(L+0.06)}{330}$$

$$L+0.06 = \frac{330}{2} \times \frac{11.5}{360} \times \frac{60}{13800}$$

$$L+0.06 = 0.22m$$

$$L = 0.16m$$

Pressure pulses travel at the speed of sound through air, this is used to determine how long the pulse will take to return. This needs to match the cam timing in order to maximise air flow into the cylinder.

b) $RPM = 10,800$

$$\text{Time for crank turn} = \frac{11.5}{360} \times \frac{60}{10,800} \quad N=1$$

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

$$L = 0.28m, \text{ far too large for a bike}$$

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If using second harmonic for both RPM's

$n=2$ @ 13800

$L = 0.05m$

The length with $n=2$ could be packaged on a ~~manifold~~
billet.

$n=2$ @ 10,800

$L = 0.08m$

c)	n	L_1	L_2
		0.05	0.08
	2	13937	10950
	3	9291.	7300
	4	6968	5475
	5	5575	4380

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

L of 0.05m gives the best harmonic spread as I would expect the engine more of the harmonics are in the desired power band.

d) Pulse tuning for an exhaust requires you too take into account temperature changes which affect the speed of sound in air. As well as working during the exhaust stroke when the piston is moving up in the cylinder instead of down

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Module Powertrain and Control, MEX 00404

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Question 3

a) Contact Force = $k(y+y_0) + ma$

Full lift

$$0 = \underset{18.8 \text{ N/mm}}{18800} (10.60 + 4) + 0.172a$$

$$a = -274.48 \div 0.172$$

$$a = -1595.8 \text{ m/s}^2 \text{ for float}$$

b)	Cam angle (°)	Valve lift (mm)	V (mm/s)	a (mm/s²)
	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

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Module Powertrain and Control, M52C00404

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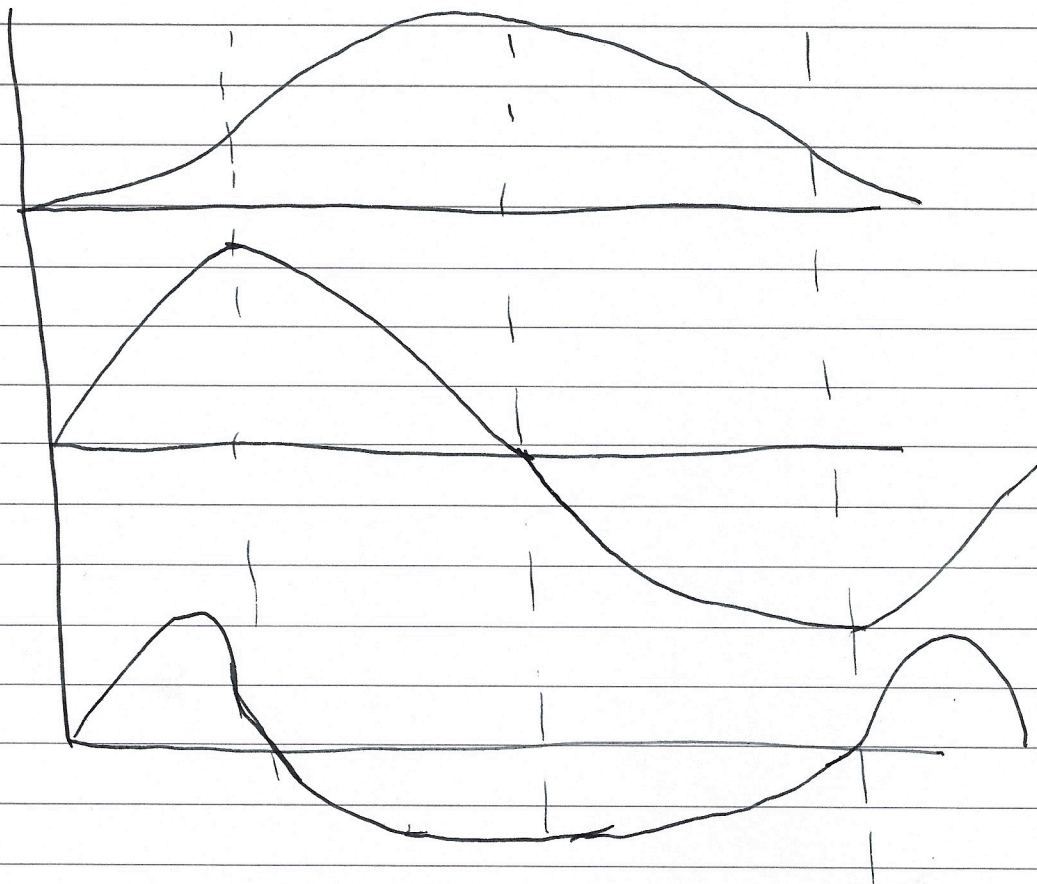
Fall lift

c)

Lift

Velocity

Acceleration



at fall lift acceleration is negative

$$d) \text{ acceleration} = \frac{-0.004 \times (6 \times 1000 \text{ rpm})^2}{1000}$$

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

$$= -1296 \text{ m/s}^2$$

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$$\text{Flat point} = -1595.8 \text{ m/s}^2$$

$$\frac{1296}{1595.8} = 0.81$$

So the max accel is 19% less than flat acceleration

e) $a = -1595.8$

$$\begin{aligned} 1000 \times (-1595.8) &= -0.004 \times (6 \times \text{cam RPM})^2 \\ \sqrt{\frac{1000 \times -1595.8}{-0.004}} &= 6 \times \text{cam RPM} \\ &= 19973.732 \end{aligned}$$

$$\text{cam RPM} = 3328.95$$

$$\text{RPM max} = 6657 \text{ rpm}$$