



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 5

LEFEL 5

EXAMINATION PERIOD
MAY 2018

CYFNOD ARHOLIADAU
MAI 2018

MODULE CODE: M5X00404

POWERTRAIN AND CONTROL

TIME: 2 HOURS

ANSWER THREE QUESTIONS OUT OF FOUR

Note that in all your answers, marks will be awarded for detailed explanation of the calculation steps

QUESTION ONE

You are required to analyse the performance of a Triumph 765cc, 3 cylinder, naturally aspirated engine induction system. The intake system consists of a plenum and three fixed inlet trumpets.

The aim is to optimise the system to achieve a power band from 10,000 to 14,200 RPM, The camshaft is symmetrical and gives a valve duration of 300 degrees. Assume maximum opening point is 110 degrees after top dead centre. Assume the speed of sound at 20°C is 330 m.sec⁻¹. Assume density of air at 20°C is 1.2 kg.m⁻³. Assume 1 BAR = 10⁵ PASCALS.

- a) Assuming the intake port length is 70mm, calculate the intake trumpet length to optimise power at 14,200 RPM. Explain fully the physics of your calculations and explain which harmonic you are using.
(7 marks)
- b) Now calculate the intake length required to achieve best tuning at 10,000 RPM. Explain which harmonic you are using and if you think these two lengths could be packaged as a variable intake system.
(3 marks)
- c) You are now required to carry out a harmonic analysis up to the 5th harmonic for both of the above lengths you chose to use. Which length do you believe provided the most useful harmonic spread?
(5 marks)
- d) You are now required to calculate the extra performance from a forward-facing plenum taking in air using the RAM effect. Explain your reasoning, calculate the additional performance potential of the forward-facing plenum at bike speeds of 30 and 90 m.sec⁻¹ respectively compared to dynamometer testing of a stationary engine in still air at the same temperature.
(5 marks)

QUESTION TWO

You are required to design an exhaust system for a Kroyer Racing Engines 7.5L V8 naturally aspirated Trophy Truck. Each cylinder bank has a completely independent exhaust system. The camshaft has a duration of 300 degrees and maximum opening point is at 110 degrees before top dead centre. Assume the speed of sound at 20°C is 330 m / sec and is proportional to the square root of the absolute temperature at higher temperatures.

- a) Assuming the exhaust port length is 80mm, calculate the length of the primary pipes into a 4 into 1 exhaust manifold to achieve best pulse tuning at 7500 RPM. Explain fully the physics of your calculations and make a suitable assumption for exhaust temperatures. Explain which harmonic you are using.
(5 marks)
- b) The engine is unsilenced. Assuming suitable exhaust temperatures and explaining your reasoning, calculate the length from the collector to the exhaust tailpipe exit to also achieve good pulse tuning at 5000 RPM. Explain which harmonic you are using.
(5 marks)
- c) Calculate the internal diameter of the primary pipes for the best performance explaining the reasoning of your calculations.
(5 marks)
- d) You are now required to study the effect of the additional harmonics. Explain how these additional harmonics can be used to improve the overall spread of torque.
(5 marks)

QUESTION THREE

The combustion process for internal combustion engines are usually defined using a function called the 'Wiebe' function.

- a) Write down the Wiebe function
(2 marks)
- b) Sketch what the Wiebe function looks like and explain how it is used to represent the combustion process.
(3 marks)
- c) Derive a formula to calculate the volume in a cylinder for every degree of crankshaft rotation.
(3 marks)
- d) Given the cylinder volume every degree and a known fuel mass, explain the steps needed to calculate the 'added pressure' at every degree of crank angle and thus the cylinder pressure with combustion.
(6 marks)
- e) Sketch a Log P against Log V diagram and explain how this can be used to determine the polytropic index in both compression and expansion.
(3 marks)
- f) Show typical graphs of valve lift, velocity and acceleration.
(3 Marks)

QUESTION FOUR

Study the data in the following table from a Ford Sigma 1.6L engine -

DYNO SPD	TORQUE	AFR	FUELMASS
rpm	Nm	-	kg/h
1000	135.9	15.2	3.71
2000	237.5	14.5	11.91
3000	257.9	12.5	22.90
4000	258.1	12.1	30.61
5000	243.7	11	40.6
6000	210.4	10.5	46.9

Assuming that the fuel calorific value is 44.29 MJ/kg and that the Stoichiometric Air/Fuel ratio by mass = 14.7, calculate the following (For the calculations assume that 1 BAR = 10^5 PA) -

- a) Calculate the fuel equivalence ratio at each RPM. (2 Marks)
- b) Calculate the Lambda at each RPM. (2 Marks)
- c) Calculate the power at each RPM. (2 Marks)
- d) Calculate the BSFC in gms/KW.hour at each RPM. (3 Marks)
- e) Calculate BMEP in BAR at each RPM. (3 Marks)
- f) Calculate overall engine efficiency at each RPM. (3 Marks)
- g) What would you do to the engine to achieve high RPM engine efficiency? (1 Marks)
- h) Calculate the potential engine performance benefit if the air inlet could be moved from a position of 50°C air temperature to position of 20°C air temperature. Explain the physics of your reasoning. (3 marks)

Diwedd/End

